

APPENDIX A COMMUNICATION ARCHITECTURE DEVELOPMENT AND DEFINITIONS

This appendix provides the definitions for the pieces comprising the communication architecture. The subsections of this appendix are further described as follows:

Section A. describes the different types of communication services.

Section A.2 provides a definition of the logical communication functions

Section A.3 lists the physical communication entities and allocates to them one or more logical communication functions.

Section A.4 describes the ITS communication network reference model and describes the interfaces between communication physical entities.

Section A.5 further identifies the relationship between the Transportation Layer and Communication Architecture definitions

A.1 Communication Services Descriptions

The communication services define the exchange of information between two points and are independent of media and application (i.e., ITS user service). In essence, they are a specified set of user-information transfer capabilities provided by the communication architecture to a user in the transportation layer. Figure A.1-1 illustrates the hierarchy of communication services, all of which are detailed in the following sections.

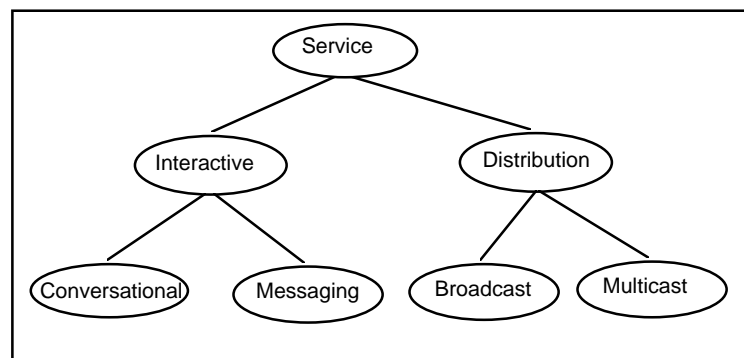


Figure A.1-1 Communication Services Hierarchy

Communication services consist of two broad categories, interactive and distribution. Interactive services allow the user to exchange data with other users or providers in real or near real time, asking for service or information and receiving it in the time it takes to communicate or look up the information.

Distribution services allow the user to send the same message to multiple other users. Each of these service categories is further broken down into subcategories, or classes. A brief description of each service class is provided below. Additional information about the interactive service classes and the distribution service classes is given in Sections A.1.1 and A.1.2, respectively.

Interactive services may be either conversational or messaging. Conversational implies the use of a two-way connection established before information exchange begins and terminated when the exchange is completed. Messaging, on the other hand, works more like electronic mail being exchanged between users. The messages are exchanged without establishing a dedicated path between the two sites. Each message is addressed and placed on the network for transmission, intermixed with messages from other users. The communications community labels this mode of communication a “datagram” service.

The distinction between interactive conversational and messaging services needs highlighting to ensure understanding of the choices made later in Table A.1-1. It also must be emphasized that the results shown here represent the iterative steps in the communications architecture design process. During the first iteration, several communication services and information types are considered for a particular data flow. However, after several steps, the initial service choice(s) are re-evaluated and refined to provide the best performance with a particular operation mode. Those service choices are the ones presented in Table A.1-1. The AID diagrams are provided in Section 3 (Level 0) and Appendix B (Level 1).

Conversational services provide the real-time response for a user to initiate a request for service, the request to get to the supporting user host for processing and the response based on that processing being transmitted to and received by the request initiator often within a second or less. An example of this process is the sensing of a Vehicle Subsystem by a Toll Collection Subsystem reading its fare card, sending the data to the Toll Administration Subsystem to verify the account's legitimacy, notifying the Toll Collection Subsystem to accept/deny the fare card, and informing the driver of the Vehicle Subsystem to proceed or to exit the toll road.

Messaging services provide for one-way data transmissions, but also support two way request-response sequences where the response time is more relaxed (typically five or ten seconds, or even more, such as travel planning queries responded to with routing instructions). An analogy is computer E-mail, where a message or file is sent to another user over a computer network and the response may be immediate (when the user is present and gives the response priority over other activities), or later, when higher priority work is completed. This is in contrast to the telephone conversation where an answer is given immediately after receiving the question (effectively last in, first out, at least for questions with easy answers). For Transportation Layer subsystems, the time frame for responses is considerably shorter than in this analogy.

Distribution services may be either *broadcast* or *multicast* and may be used over wireline and/or wireless communication links. Broadcast messages are those sent to all users while multicast messages are sent only to a subset of users. Multicast differs from broadcast in its use of a designated address for all users and user groups. Examples of broadcast information might include current weather or road conditions, whereas multicast information might be information sent to all drivers working for a specific company. A changing group membership could be the set of users traveling between two locations or with a certain destination, for which unique information must be transmitted.

Each of these service categories is oriented to carrying certain types of information. For example, a conversational service can provide voice (pure analog or digitized), data or video at various levels of quality through different types of connections and using different service features. The service characteristics are listed in Tables A.1.1 and A.1.2 under the heading “Bearer Service.”

In addition to the above, each communication service can be connection-oriented or connection-less. The former is analogous to the telephone system, where a link is established (number dialed, the called party answers), the information transfer takes place and the link is terminated (each party hangs up). The connection-less service is analogous to the postal system, where each letter has the full address and is routed from node to node through the system, independently of all the other letters. Unacknowledged connection-less service is often called *datagram service* and is often acceptable when accurate reception is not critical and the extra overhead is not worth the cost. When acknowledged, it is called *acknowledged datagram service*, and is analogous to registered mail.

Additionally in Tables A.1-1 and A.1-2, for each class of interactive service, the tables list the types of information that can be transferred, the service description (e.g., end-end connection, or store/forward) and bearer service. The interactive and distribution services can be offered over wireline links, wireless links, or both.

Note that private lines, readily available from a local Telco or procured by an agency (totally private), support rates from 56/64 kbps to T1 (1.544 Mbps), T2 (6.312 Mbps), T3 (44.736 Mbps), T4M (274.176 Mbps), and SONET OC-N (up to 2.48 Gbps). The various rates listed in Tables A.1-1 and A.1-2 indicate full or partial use of such lines for rates above normal voice-grade twisted-pair rates, which routinely span 300 bps to 14.4 kbps and are now being extended to 28.8 kbps and above with V.32 FAST modems, etc.

A.1.1 Interactive Services

Two classes of service are identified under this category: conversational and messaging. In both cases, information can be transferred bi-directionally, point-point. The transfer may be transaction-based, unidirectional send/retrieve, or store-and-forward. These are listed in Table A.1-1.

Table A.1-1 Interactive Services

Service	Type of Information	Service Description	Bearer Service
Conversational Description: Real-time (RT), or near real-time, end-end essential to many information transfer applications, usually with an established connection.	Voice	End-End Voice Connection	Mode: Circuit Access: Demand Symmetry: 2-way, RT Rates: 2.4 – 64 kbps
	Data = Text, Audio, Computer bits	End-End Data Connection	Mode: Circuit Access: Demand Symmetry: 2-way, RT Rates: 300 bps – 2.48 Gbps <hr/> Mode: Packet (connection-oriented) Access: Demand Symmetry: 2-way, RT Rates: 4.8 kbps – 622 Mbps <hr/> Mode: Non-switched Access: Full-period Symmetry: 2-way, real-time Rates: 4.8 kbps – 2.48 Gbps
	Video	End-End Video Connection	Mode: Circuit Access: Demand Symmetry: 2-way, RT Rates: 64 kbps – 155 Mbps
Messaging Description: User-user information transfers that do not require real-time, dedicated connections.	Voice	Retrieve Send Store/Forward	Mode: Circuit/Packet Access: Demand, Reserved, Random Symmetry: Bi-directional Rates: 2.4 – 64 kbps
	Data = Text, Audio, Image, Computer bits	Retrieve Send Store/Forward	Mode: Packet (connection-less) Access: Demand, Reserved, Random Symmetry: Bi-directional Rates: Low-rate: 4.8 kbps – 64 kbps Hi-rate: 128 kbps – 622 Mbps
	Video	Retrieve Send Store/Forward	Mode: Circuit/Packet Access: Demand, Reserved, Random Symmetry: Bi-directional Rates: 64 kbps – 155 Mbps Slow-scan: ² 14.4 kbps

A.1.2 Distribution Services

Distribution Services provide for the unidirectional dissemination of information from point to multipoint, where the multipoint may be all users on the network (broadcast) or a subset of all users on the network identified by a group address (or by multiple individual addresses).

Table A.1–2 Distribution Services

Service	Type of Information	Service Description	Bearer Service
Broadcasting Description: Information is being communicated to all parties within a coverage area or to parties attached to a wireline distribution plant. In some cases, the receiving party can control which of the broadcast information messages to accept.	Voice	Voice message - Prerecorded - Live Narration	Mode: Direct Packet Symmetry: Unidirectional Rates: 2.4 – 64 kbps
	Data = Text, Audio, Image, Computer bits	Data broadcasting	Mode: Broadcast Symmetry: Unidirectional Rates: Low-rate: 4.8 kbps – 64 kbps Hi-rate: 128 kbps – 2.4 Gbps
Multicasting Description: Information is sent to a specified group of users spread across several zones or within one zone; not all users receive the information because of an addressing scheme.	Voice	Voice message broadcasting - Prerecorded - Live Narration	Mode: Direct Packet Symmetry: Unidirectional Rates: 2.4 – 64 kbps
	Data = Text, Audio, Image, Computer bits	Data broadcasting	Mode: Broadcast Symmetry: Unidirectional Rates: Low-rate: 4.8 kbps – 64 kbps Hi-rate: 128 kbps – 45 Mbps

A.1.3 Location Services

Location services mean the ability of a service provider to locate the user, or the user to locate himself by using electronic means. (In this discussion, neither looking at a paper map or reporting one's position using voice after visual observation count as meaningful location services!) Location services entail the performance of processing and/or measurements of signals that are transmitted and received by the user or an infrastructure with which the user interacts.

Location services are key to the provision of a number of ITS user services across many application areas, for example, route guidance, mayday, vehicle probes, and fleet management. They also play a critical role in services that are related to ITS; such as E-911 and mobile yellow pages. In fact, the Cellular Telecommunication Industry Association (CTIA) has recently reached an agreement with the FCC and a number of associations of emergency officials on required service availability and

performance. All commercial mobile wireless service providers will have to support some location determination capability whose accuracy is 125 m root-mean-square within five years. The choice of the locating technique and service mechanism are left open to the wireless provider. This will ensure that keen competition will exist between the various location technology and service offerings, and the most effective approach may become a standard. Quite likely, however, different location services will co-exist and flourish and be adopted by different users depending on their needs.

The location services use a variety of techniques for estimating user location which are described below. The service offerings use one or more of these technical approaches as will be discussed briefly.

A.1.3.1 Location Determination Techniques

Location determination may use different attributes of received signals, these are: signal strength, time of arrival in reference to a standard precise clock, and direction of signal arrival. A triangulation-type of computation is performed on multiple signals. The signals that are used for this process are either generated from transmitting towers (or satellites) or from the mobile unit (i.e., subscriber).

- The signal strength technique: The attenuation of the signal level (power) as a function of distance from the transmitting unit has been studied extensively. The measured signal level (i.e., power) from a transmitter, when received at several base sites can be used for estimating the distance from the transmitter. The location determination algorithm uses propagation related data and triangulation to estimate the location of the unit. The main problem with this approach is its inherently low reliability and accuracy. This is because the propagation medium is dynamic and cannot be modeled with a high degree of accuracy. (For example, the propagation environment suffers from multipath, shadowing, and scattering, all with a fair degree of randomness.)
- The time difference of arrival technique: This technique measures the arrival time of signals from multiple transmitters, relative to a reference standard clock. The time of arrival information is used for estimating the distance from the transmitter(s). The location determination algorithm (e.g., triangulation) uses this information to estimate the position of the unit. This technique is well known and has been used in RADAR applications as well as the Global Positioning System (GPS). Several terrestrial systems which use this general approach also exist. The accuracy of this method is a function of the signal and processing complexity. Complex systems use spread spectrum signals for determining the time delays; some can achieve accuracy on the order of meters. The challenges for this technique involve the accuracy of the reference time and multipath.
- Angle of arrival technique: This technique utilizes phased array antenna technology for detecting the angle of arrival of the transmitted signal. In this technique the mobile units transmit the signals and multiple fixed receiver stations detect the angle of arrival. The complexity in this technique relates to the receiving antenna hardware, and the algorithm. One of the big challenges to this method is the effect of multipath, especially in metropolitan areas, which tend to have strong reflectors.

A.1.3.2 Types of Location Services

The location determination techniques described above are implemented in several different configurations. These include:

Terrestrial Infrastructure based location services

In this category the signal attributes of an existing (shared use) wireless infrastructure, such as cellular, or a separate, dedicated infrastructure are used. To provide the service the infrastructure is equipped with required hardware for detecting the features of the desired signals from the subscribers. Such a service

can use angle of arrival, time of arrival, as well as signal strength technique for estimating the location of a mobile unit. For example:

- The cellular infrastructure (i.e., base stations) will be equipped with special hardware for detecting the attributes of mobile cellular calls. The location determination is performed at a management center connected to the base stations, and then the information is forwarded to the end user via wireline or wireless links. The advantage of this service approach would be the lower cost for the subscriber, since the subscriber unit would have minimum hardware complexity. (For the cellular case there would be no to minimum modification of the handsets). However, this service will typically support a class of mobile units that have a cellular voice capability.
- A dedicated or separate infrastructure can be used for triggering and receiving signals from mobile units. Such a service can use any of the above techniques for location estimation. The draw back will be the deployment cost of a new infrastructure, in addition to the service and terminal cost.

Space infrastructure based Location Services

Here the most common approach is that of GPS, where the location determination is performed entirely within the mobile unit, basically using time difference of arrival. In this case, a relatively more complex unit compared to the infrastructure based approach would be required, but autonomous operation is achieved. Other services offer hybrid approaches. Service offerings have been proposed where the necessary satellite signal attributes are detected in the subscriber's terminal but not completely processed. In stead, they are reported to a central office for location computation, map matching etc. This will result in a scaled down user unit hardware, but will require a wireless data link between the mobile and the center.

Various other location service offerings will be introduced in the coming years in conjunction with low earth orbiting satellite systems.

A.1.3.3 Service Deployment Issues

Each of the above configurations represents a unique approach to obtaining the location of a subscriber, and making it available to the ITS service provider. Each has its own advantages and potential shortcomings. A complete tradeoff takes into account extensive technical field performance results interpreted in the context of the application requirements, technology costs associated with required infrastructure and/or terminal modifications, deployment feasibility, human factors, applicable user base, as well as the service offering mechanism.

A.2 Logical Communication Function Definitions

Based on the objectives of the communication architecture, a list of logical functions to support the ITS system communication requirements was identified. The primary logical communication functions can be confined to the following:

Wireless Access: permits a user to access the network/communication resource from a tetherless device (typically in, or needing communication with, a mobile element).

Wireline Access: permits a user to access the network/communication resource through a fixed device.

Switching: interconnects functional units, transmission channels, or telecommunications circuits for as long as required to convey a signal.

Routing: provides for the transparent transfer of data between two transport entities, even if they are dissimilar.

Registration: describes a set of procedures for identifying a user to the network resource as being active.

Authentication: ensures that the current user is legitimate, friendly, and acceptable to the network.

Interworking: supports interaction between dissimilar operation modes and networks, specifically handling the conversion of physical and electrical states and the mapping of protocols.

Validation/Billing: associates a user's profile with a valid accounting record to ensure payment for network usage and/or to compile usage statistics.

Operations Support: provides management and administration functions for the various Communication Architecture entities.

A.3 Network Entity Definitions

The functional entities that make up the communication architecture were derived from existing and emerging infrastructure specifications and standards (*e.g.*, TIA, ITU, Bellcore, ANSI). These basic building blocks form the foundation of a generic communication system. As with the transportation layer, each functional entity consists of one or more logical functions. The description of each functional entity shows the mapping of that entity to the logical entities it supports.

User Device	Access to a network or communication link through wireless or wireline media. The device includes a terminal connected to a transceiver and supports voice, data, and/or video information types.
User Profile Module	User-specific information used for registration, authentication, information delivery, mobility management, and billing. This module holds user-specific characteristics such as personal schedule data, credit card data, encryption keys, preferred service mode, etc. (<i>e.g.</i> , smart card).
Switch	<p>Switching functions for information delivery as well as routing. Two types of switches are considered — circuit-switch and packet-switch¹. The circuit switch accommodates circuit-mode operation for voice and data information types and connects to wireline networks such as the PSTN and ISDN. One circuit-switch can handover a live connection to another circuit-switch.</p> <p>The packet switch accommodates packet mode operation for data information types and connects to wireline networks such as the PDN, ISDN, and Internet. One packet-switch can handover a live connection to another packet-switch.</p> <p>For interworking between two different switch types, refer to the Interworking Function.</p>
Wireless Controller	The Wireless Controller (WC) provides an interface between multiple wireless devices and the switches. The WC allocates wireless facilities and coordinates network facilities. To meet the objective of uninterrupted coverage in the cell-based system, the controller performs handover (handoff) between wireless base stations served by the same controller. The Wireless Controller can also be viewed as the back-end for a suite of short-range beacons.
Wireless Base Station	The Wireless Base Station provides access for information delivery to and from tetherless users. The Wireless Base Station handles radio frequency exchanges and converts the information coming over the radio link into baseband for the subsequent system components. The air interface may be realized in many combinations of physical interfaces, link layers, and multiple access techniques.
Interworking Function	The Interworking function provides transmission, including routing, between dissimilar networks, especially for inter-mode communication (<i>e.g.</i> , circuit-to-packet, packet-to-circuit). This function can be viewed as an adjunct "black-box" capable of performing functions beyond the domain of the switch or interconnected network. It is loosely defined, and can be configured according to the specifications of the network service provider.

¹Although Asynchronous Transfer Mode (ATM) utilizes cell-switching, it is no more than a fast-packet-switch algorithm, and therefore classified as packet-switching.

Registration, mobility management, authentication, validation are supported in the signaling plane rather than by the transport network. The defined entities include Personal Registers and Terminal Registers, with the former archiving information related to an individual and the latter storing information associated with a device. This subtle and important distinction satisfies the objective of seamless operation and provides the user with tremendous flexibility. Records are maintained for all information types (*i.e.*, voice, data, video). Note that not all data flows need to have their user profiles tracked, especially for free or highly localized applications. Detailed elaboration of the public databases is beyond the scope of this study.

Example Profile Databases include:

- Personal Home Location Register (HLR_p): stores user identity and contains user information (*e.g.*, current user location, current device, service profile).
- Terminal Home Location Register (HLR_t): stores device identity and contains device information (*e.g.*, current station location, device capabilities, device identity for authentication).
- Personal Visitor Location Register (VLR_p): stores information regarding a user that is now associated with a device being served by a "visiting" network. Information associated with this user is retrieved from the HLR_p.
- Terminal Visitor Location Register (VLR_t): stores information regarding a device that is being served by a "visiting" network. Information associated with this user is retrieved from the HLR_t.
- Authentication Center (AC): manages encryption keys associated with an individual user or user device and verifies the legitimacy of the user.

Wireline Network

The wireline network provides access for information delivery as well as inter-entity (except wireless) connectivity. Wireline network resources handle information transfer between the switch and the fixed user device or among user devices. Although the wireline network is a cloud or collection of multiple nodes, each cloud will be viewed as one virtual node.

Example Wireline Networks include:

- Public-Switched Telephone Network (PSTN): is the ubiquitous telephone network, operating in circuit-mode. A variety of switching technologies, physical interfaces media, and link layer services contribute to a wide range of implementation choices. Basically, there is something for everyone.
- Integrated Services Digital Network (ISDN): offers interactive voice and data services, operating in both circuit and packet mode. The choice of ISDN interface (BRI or PRI) determines the available data rate.
- Internet: provides users with a connection-less datagram carriage protocol accommodating interactive as well as distribution services. It has witnessed explosive growth during the past year. Access is becoming near-ubiquitous. To accommodate growth, OSI is introducing a new routing protocol, CLNP (Connection-less Network Protocol), which supports a 256-bit address field versus the 32-bit address field used in IP.
- Packet Data Network (PDN): provides users with traditional interactive packet services, typically virtual circuit carriage (*e.g.*, X.25 networks, Frame Relay networks).
- Local Networks (LAN, MAN, WAN): provide both switched and non-switched interactive and distribution services among data communicating devices within a local, metropolitan, and wide area. Typically, switching becomes necessary for the WAN case (*i.e.*, interconnecting two or more MANs).

A.4 Network Reference Model

As discussed previously, the communication architecture design process consists of several steps. The previous sections presented the communication logical functions and the communication physical entities. The architecture design process proceeds here with the development of the Communication Network Reference Model. This model provides an architecture or structure that shows how various communication technologies can implement the Architecture Interconnect Diagrams (Level 0 AIDs in Section 3; Level 1 AIDs in Appendix B).

The network reference model shown in Figure A.4-1 is a generic abstraction representative of several reference models developed for standard commercial systems including Personal Communications Services (PCS) architectures, Groupe Speciale Mobile (GSM) or DCS-1800, TIA-IS-41, Cellular Digital Packet Data (CDPD), Intelligent Network (IN) architectures, etc. Boxes represent the various physical equipment (with descriptive uppercase letters) that perform the communication functions. Identified by lowercase letters (s , v , u_1 , u_2 , u_3), the interfaces important to ITS are described in the following paragraphs.

Since the wireline segment encompasses standard wireline configurations, the ITS-critical elements from a standards perspective are those comprising the wireless portion on the left side of Figure A.4-1. The wireless portion consists of the User Profile Module (UPM), the User Terminal (UT), the Wireless Transceiver (WT) and the Wireless Base Station (WBS). The connections through the Dedicated Terminal and various User Terminals are shown in the column of boxes on the right. The equipment in the center is the existing public telecommunications services, so the details are transparent to ITS, which is a major benefit to the ITS community. *All management, operations, expansion, and improvement costs are shared with the wider set of all telecommunications users.*

This is a very important point to jurisdictions and agencies who prefer to procure and trench their own network along the right-of-way. Whereas a financial sensitivity analysis may point to a private solution, it frequently does not consider the enormous Operation, Administration, Management, and Provisioning (OAM&P) fees that the agency will have to pay the telecommunications vendor during the system's life cycle.

The most important reference point is the wireless interface (u) connecting the WBS and the wireless transceiver. To meet most of the communication element's objectives, as well as those of the overall architecture, it is imperative that the air interface become standard. The wireless portion of the architecture is manifested in 3 different ways, all of which demand a nationally-acceptable air link. Therefore, the u interface is realized in three ways: u_1 , u_2 , u_3 , with each interface corresponding to one of the wireless manifestations, as defined:

- u_1 defines the wide-area airlink to one of a set of base stations providing connections between mobile users or mobile and PSTN-connected users. It is typified by the current cellular telephone networks or the larger cells of Specialized Mobile Radio, etc., for two-way communication, and FM subcarrier or paging networks for one-way communication;
- u_2 defines the short-range airlink used for close-proximity (typically, less than 50–100 feet) transmissions between a mobile user and a base station, typified by transfers of vehicle identification numbers at toll booths; and
- u_3 addresses the vehicle-vehicle (AHS-type) airlink, for high data rate, burst, usually line-of-sight transmission with high reliability between vehicles, where standards are in their infancy.

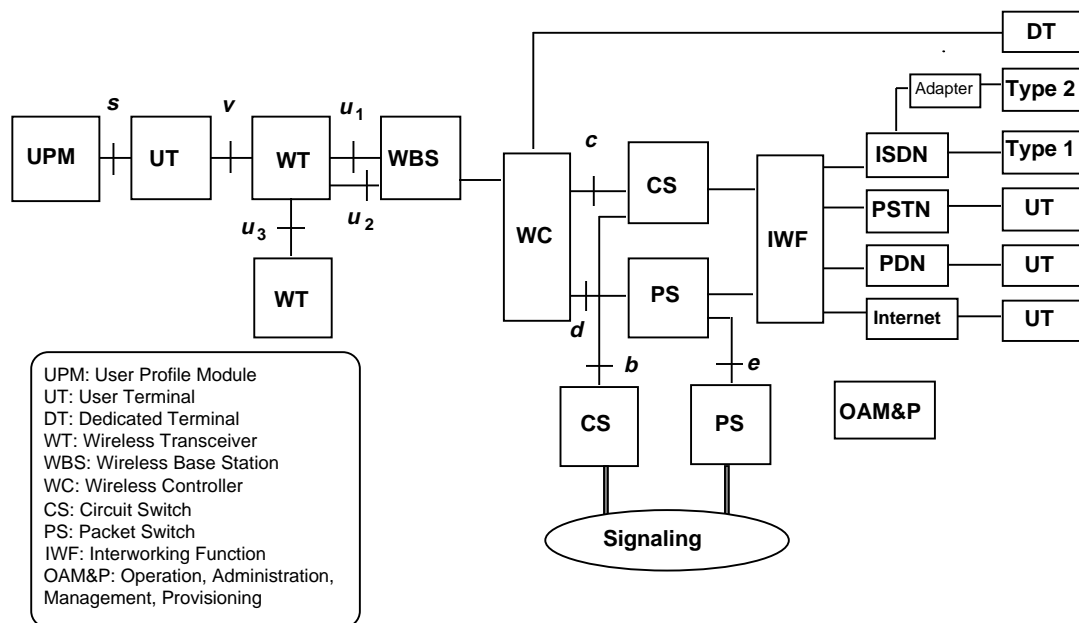


Figure A.4-1 Network Reference Model for the Communications Architecture

On the wireline side, user devices attach through the PSTN, ISDN, Internet, or PDN, operating in circuit or packet mode. The dedicated terminal accesses non-switched, dedicated infrastructures (e.g., a direct connect to a base station's wireless controller). An Interworking Function (IWF) mediates between two different operational modes. As will become evident in later sections, the IWF assumes more than one composition. In some implementations, there may be no IWF between the switched and the wireless networks. OAM&P (Operations, Administration, Management, and Provisioning) systems interface to virtually all functional entities except user devices.

The switches appearing in this model are the functional communication entities mediating wireless traffic. It is likely that the circuit switch handles both voice and data information types whereas the packet switch handles data exclusively. The *b* and *e* interfaces are points of connectivity between switches of the same kind, and noted as reference points because neighboring switches must be able to communicate with each other to handover live connections, regardless of information type. Although both *b* and *e* interfaces should be considered for standardization, they are beyond the purview of the ITS community.

The interfaces between the switches and the wireless controller (WC) can be considered for standardization, if only to maintain a network open to all vendors (*i.e.*, a network operator does not have to purchase a switch, WC, and WBS from the same vendor). The *c* and *d* interfaces may be standardized by the telecom community.

The wireless transceiver is actually the RF front-end to a user terminal. The terminal contains the protocol control logic to establish and tear-down connections and to process packets. Given the objective of integrating maximum functionality into a single device, the user terminal may have the capability to handle both voice and data information types (slow-scan video or compressed video, such as MPEG files, are considered as data types rather than video types). Identity information (either personal or terminal) is described by the User Profile Module, which may be hardwired into the terminal or portable (*e.g.*, a smartcard). The team favors the portable approach to the UPM, but does not preclude terminals with hardwired UPMs. The UPM-terminal interface, noted as the *s* interface, should be standardized to

maintain an open and flexible system. A traveler renting a vehicle in a foreign city should be able to use a UPM to activate a terminal in the vehicle. For the short-range information transfer scenario, the terminal may be a dock for a UPM that stores payment information.

As shown in Figure A.4-2 entities and interfaces comprise the signaling plane, that part of the network which controls user access and sets up circuit connections or addresses packets for transmission along the available route. The user equipment must provide certain information to the signaling functional entities to operate. The entities of importance to the ITS system are the Home Location Register (HLR), the Visitor Location Register (VLR), in both cases for the user as either a person or a terminal, and the Authentication Center (AC), the entity which may manage the encrypting keys associated with an individual user, if such functions are provided for within the network. A detailed description of these interfaces is beyond the scope of the study because most of these entities have been deployed and specified in existing/emerging standards documents. Access to the signaling plane is accomplished by a TCAP Application Protocol delivered over SS7 MTP or X.25 links from circuit and packet switches. ISDN also requires access to the signaling plane for control data. For more details on this component, refer to ANSI Intelligent Networks architectures and TIA IS-41.

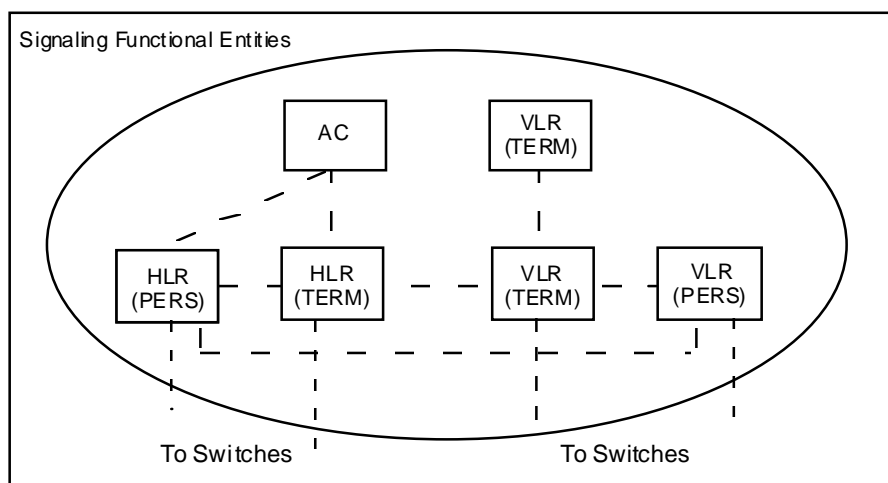


Figure A.4-2 Signaling Plane Entities

A.5 Communication Architecture Linkage

This section further identifies the relationship between the Transportation Layer and Communication Architecture definitions. This is accomplished by mapping the communication services to the data flows identified in the Transportation Layer, generating the Architecture Interconnect Diagrams (AIDs), identifying the Architecture Renditions (ARs), mapping the AIDs to the ARs, identifying the Architecture Interconnect Specifications (AISs) (based on the technology assessment) which completes the definition of the communication architecture.

A.5.1 Mapping Communication Services to Data Flows

The figure that was provided earlier illustrating the Communications Architecture Design Process is shown again in Figure A.5-1 with the Map Data Flows-Communications block highlighted to guide the reader to the next step in the communication architecture design process.

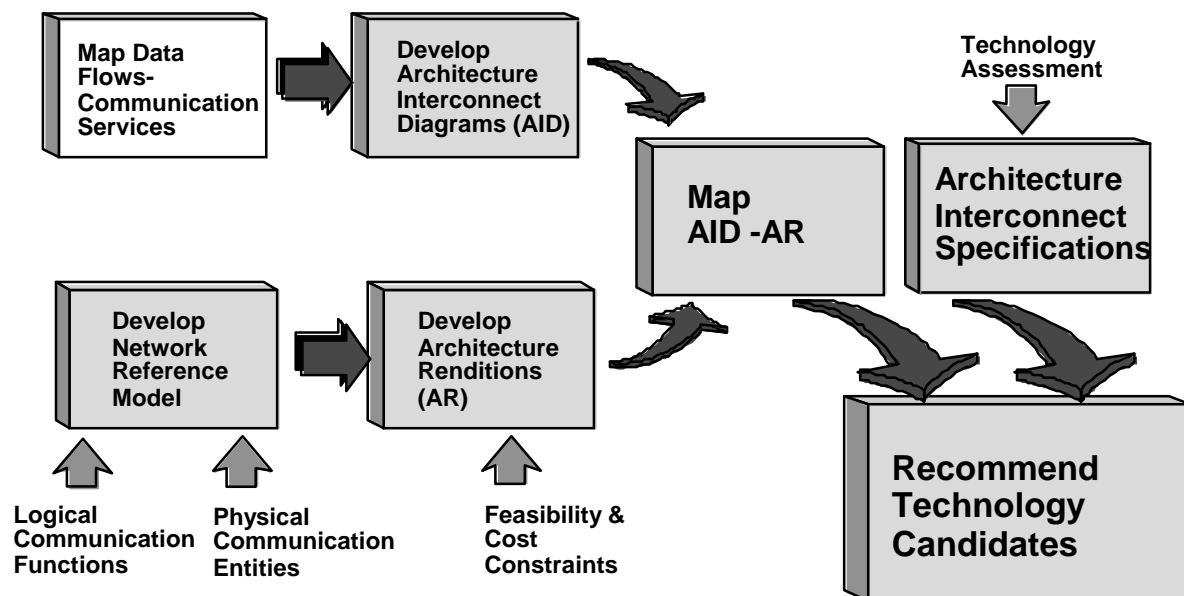


Figure A.5-1 Communications Architecture Development Process – Mapping Data Flows to Communication Services

Table A.5-1 illustrates the mapping between data flows derived from the logical architecture and communication services presented in Section A.1. Mapping of the communication services to the data flows establishes the first link between the transportation layer and the communication architecture, and this initial link depends on the completion of two technical architecture milestones. First, the message sizes and data requirements are to be carried over from Section 6, Data Loading Analysis. Second, the physical architecture that allocates logical functions (see Logical Architecture Document) to subsystems necessitates a partitioning exercise, which defines the data flows that require communication. This mapping is an iterative procedure, calibrated by feedback from the logical and physical architectures (and in turn the ITS stakeholders) by retracing the steps shown in Figure A.5-1.

The mapping process facilitates the synthesis of a preliminary physical communication architecture for several reasons. First, it translates the needs of the data flows, which are traced to the needs of the user services, identified in the transportation layer, to the communication architecture. The mapping shows that some data flows can be accommodated by both wireless links as well as wireline links. Going a step further, the mapping also illustrates communication services that can support the data flow. For example, the *Fleet_To_Driver_Update* flow requires a Messaging service over a packet data network. More than one service are offered for several data flows to maintain maximum flexibility in designing the communication architecture, which accommodates alternative implementations.

The second reason is that the mapping process serves as the baseline for developing an application set protocol. The application protocol provides ITS users with a standardized ubiquitous message set that can be encapsulated with any lower level protocol suite. For example, the message set can sit on top of an IP, X.25, or Frame Relay stack.

Third, this mapping process serves, in some respects, as a validation between the physical and logical architectures, as well as the data loading analysis.

The column names provided in the Table A.5-1 are described below:

Source & Destination interfaces: Entries in these columns identify the paired transportation subsystems (e.g., CVAS, FMS, External) which are identified to exchange the designated information or data flow (i.e., the paired transportation subsystems are the end points of the communication link that carries the data flow). The first entry (e.g., CVAS or Commercial Vehicle Administration Subsystem) corresponds to the originating, or source, entity, and the second to the destination, or sink (e.g., FMS or Freight and Fleet Management Subsystem). The transportation subsystem interface entries are derived from the transportation layer physical architecture. Acronyms for the subsystem names are used in the table and are defined below for the reader's convenience.

CVAS	Commercial Vehicle Administration Subsystem
CVCS	Commercial Vehicle Check Subsystem
CVS	Commercial Vehicle Subsystem
VS	Vehicle Subsystem
EMMS	Emissions Management Subsystem
EM	Emergency Management Subsystem
EVS	Emergency Vehicle Subsystem
FMS	Freight and Fleet Management Subsystem
ISP	Information Service Provider Subsystem
PIAS	Personal Information Access Subsystem
PMS	Parking Management Subsystem
RS	Roadside Subsystem
RTS	Remote Traveler Support Subsystem
TAS	Toll Administration Subsystem
TCS	Toll Collection Subsystem
TMS	Traffic Management Subsystem
TRMS	Transit Management Subsystem
TRVS	Transit Vehicle Subsystem
PS	Planning Subsystem

Architecture Flow: Entries in this column identify the actual data flows that are transferred between the two transportation subsystems specified in the preceding column. The allocation of the data flows to specific paired subsystem interfaces was derived from the transportation physical architecture. However, the composition of the data flows was obtained from the logical architecture.

Communication Service: Entries in this column correspond to the communication services described in Section A.1. Mapping the communication services to the data flows links the transportation layer and the communication architecture; the link transforms two de-coupled, and seemingly independent frameworks into a unified architecture. Selection of communication service entries is based on the data flows definition presented in the Transportation Layer section of the *Physical Architecture* document, which provides insight into the requirements of the data flow. Thus the Data Dictionary indicates the *transit_information_requests* message between Information Service Provider Subsystem and the Transit Management Subsystem is a short message. Together with the fixed location of each entity, the shortness leads to the determination that the message can be carried over the existing wired communication services, either on a switched or non-switched basis, depending on the total traffic load for the individual locations. The operation mode can be either circuit, where a pair of wires is set aside for the use of that message, or packet, where the message is divided up into short blocks and each block is individually sent from switch to switch on a path from the source to the destination. At the destination the packets are reassembled into the message and provided to the user. The final choice between circuit and packet is the cost, first between existing plant and new, but then at the technology level, the cost of wires (or

transmitter / receivers, modems) and the cost of computing (dividing up messages or data blocks into packets and reassembling them). With the dropping price of computers and the constant or increasing cost of cable plant, the direction of current technology is toward packet switching.

Rationale & Critical Attributes: When necessary for clarification, this column provides justification for the choices in the preceding column, communication service. Most choices reflect quantitative refinement from the operational requirements and the data loading analysis. Note that conversational data may reflect the desire to provide early implementation or implementation in rural areas where user density may not support a more advanced technology in the near to mid term future. Conversational speech capability is noted for those message types which today may be conveyed by voice.

Note

Table A.5-1 includes voice services in order to accommodate existing and legacy systems. However, this document focuses on data services since they are envisioned to be the more efficient modes of communication and would be adopted by future systems.

Table A.5-1 Data Flow – Communications Service Mapping

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
1	CVAS	Commercial Vehicle Administration	credentials information	CVCS	Commercial Vehicle Check	W,U1t	Conversational data, messaging data	The CVAS could be a transportable entity. Some transactions may need real time support
2	CVAS	Commercial Vehicle Administration	safety information	CVCS	Commercial Vehicle Check	W,U1t	Conversational data, messaging data	
3	CVAS	Commercial Vehicle Administration	CVO database update	CVCS	Commercial Vehicle Check	W	Conversational data, messaging data	
4	CVAS	Commercial Vehicle Administration	international border crossing data	CVCS	Commercial Vehicle Check	W	messaging data	
5	CVAS	Commercial Vehicle Administration	electronic credentials	FMS	Fleet and Freight Management	W,U1t	messaging data	The CVAS could be a transportable entity.
6	CVAS	Commercial Vehicle Administration	compliance review report	FMS	Fleet and Freight Management	W	messaging data	
7	CVAS	Commercial Vehicle Administration	activity reports	FMS	Fleet and Freight Management	W	messaging data	
8	CVAS	Commercial Vehicle Administration	operational data	PS	Planning Subsystem	W	messaging data	
9	CVAS	Commercial Vehicle Administration	payment request	X21	Financial Institution	W	Conversational data, messaging data	
10	CVAS	Commercial Vehicle Administration	tax-credentials-fees request	X22	Government Administrators	W	messaging data	
11	CVAS	Commercial Vehicle Administration	credentials and safety information request	X59	Other CVAS	W	messaging data	
12	CVAS	Commercial Vehicle Administration	CVAS information exchange	X59	Other CVAS	W	messaging data	
13	CVAS	Commercial Vehicle Administration	violation notification	X62	Enforcement Agency	W	messaging data	
14	CVAS	Commercial Vehicle Administration	license request	X64	DMV	W	messaging data	
15	CVAS	Commercial Vehicle Administration	credentials and safety information response	X65	CVO Information Requestor	W	messaging data	
16	CVCS	Commercial Vehicle Check	credentials information request	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
17	CVCS	Commercial Vehicle Check	roadside log update	CVAS	Commercial Vehicle Administration	W	Messaging data	
18	CVCS	Commercial Vehicle Check	citation and accident data	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
19	CVCS	Commercial Vehicle Check	safety information request	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
20	CVCS	Commercial Vehicle Check	international border crossing data update	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
21	CVCS	Commercial Vehicle Check	clearance event record	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
22	CVCS	Commercial Vehicle Check	pass/pull-in	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
23	CVCS	Commercial Vehicle Check	safety inspection record	CVS	Commercial Vehicle Subsystem	U2	Conversational Data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
24	CVCS	Commercial Vehicle Check	screening request	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
25	CVCS	Commercial Vehicle Check	lock tag data request	CVS	Commercial Vehicle Subsystem	U2	Conversational Data	
26	CVCS	Commercial Vehicle Check	border clearance request	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
27	CVCS	Commercial Vehicle Check	on-board safety request	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
28	CVCS	Commercial Vehicle Check	border clearance event record	CVS	Commercial Vehicle Subsystem	U2	Conversational Data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
29	CVS	Commercial Vehicle Subsystem	border clearance data	CVCS	Commercial Vehicle Check	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
30	CVS	Commercial Vehicle	on board safety data	CVCS	Commercial Vehicle	U2	Conversational data	Short range communication,

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
		Subsystem			Check			for moving vehicles when passing by specific locations at speeds up to 70 mph
31	CVS	Commercial Vehicle Subsystem	screening data	CVCS	Commercial Vehicle Check	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
32	CVS	Commercial Vehicle Subsystem	lock tag data	CVCS	Commercial Vehicle Check	U2	Conversational Data	
33	CVS	Commercial Vehicle Subsystem	driver and vehicle information	FMS	Fleet and Freight Management	U1t	messaging data, location data	bursty transactions
34	CVS	Commercial Vehicle Subsystem	on board vehicle data	FMS	Fleet and Freight Management	U1t,U2	messaging data	Bursty transactions
35	CVS	Commercial Vehicle Subsystem	processed cargo data	VS	Vehicle	W	messaging data	
36	CVS	Commercial Vehicle Subsystem	lock tag data request	X08	Commercial Vehicle	W	Conversational Data	
37	EM	Emergency Management	emergency dispatch requests	EVS	Emergency Vehicle Subsystem	U1t	Conversational speech, messaging data	Low delay bursty data or conversational speech
38	EM	Emergency Management	assigned route	EVS	Emergency Vehicle Subsystem	U1t	Conversational speech, messaging data	Low delay bursty data or conversational speech
39	EM	Emergency Management	Hazmat information	EVS	Emergency Vehicle Subsystem	U1t	Conversational speech, messaging data	Low delay bursty data or conversational speech
40	EM	Emergency Management	Hazmat information request	FMS	Fleet and Freight Management	W	Conversational data, messaging data	
41	EM	Emergency Management	emergency vehicle route request	ISP	Information Service Provider	W	Conversational speech, messaging data	
42	EM	Emergency Management	incident information	ISP	Information Service Provider	W	Conversational speech, messaging data	
43	EM	Emergency Management	emergency acknowledge	PIAS	Personal Information Access	W,U1t	Conversational data, messaging data	Wide area communication to PDA
44	EM	Emergency Management	operational data	PS	Planning Subsystem	W	Conversational data, messaging data	
45	EM	Emergency Management	emergency acknowledge	RTS	Remote Traveler Support	W,U1t	Conversational speech, messaging data	Wide area wireless communication to transportable units
46	EM	Emergency Management	incident information	TMS	Traffic Management	W	Conversational data, messaging data	
47	EM	Emergency Management	emergency vehicle greenwave request	TMS	Traffic Management	W	Conversational data conversational speech	

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
48	EM	Emergency Management	incident response status	TMS	Traffic Management	W	Conversational data, messaging data	
49	EM	Emergency Management	transit emergency coordination data	TRMS	Transit Management	W	Conversational data, messaging data	
50	EM	Emergency Management	emergency acknowledge	VS	Vehicle	U1t	Conversational data conversational speech	Low delay bursty data
51	EM	Emergency Management	emergency status	X13	E911 or ETS	W	Conversational data conversational speech	
52	EM	Emergency Management	map update request	X23	Map Update Provider	W	messaging data	
53	EM	Emergency Management	emergency coordination	X30	Other EM	W	Conversational data, messaging data	
54	EMMS	Emissions Management	operational data	PS	Planning Subsystem	W	messaging data	
55	EMMS	Emissions Management	vehicle pollution criteria	RS	Roadway Subsystem	W	messaging data	
56	EMMS	Emissions Management	widearea statistical pollution information	TMS	Traffic Management	W	messaging data	
57	EMMS	Emissions Management	map update request	X23	Map Update Provider	W	messaging data	
58	EVS	Emergency Vehicle Subsystem	emergency vehicle driver status update	EM	Emergency Management	U1t	messaging data	Low delay bursty data or live voice.
59	EVS	Emergency Vehicle Subsystem	emergency vehicle driver inputs	EM	Emergency Management	U1t	Conversational speech, messaging data	Bursty data or live voice. Minimum delay in data communication for forward and reverse link may be required
60	EVS	Emergency Vehicle Subsystem	emergency vehicle dispatch acknowledge	EM	Emergency Management	U1t	Conversational speech, messaging data	Bursty data or live voice. Minimum delay in data communication for forward and reverse link may be required
61	EVS	Emergency Vehicle Subsystem	emergency vehicle preemption request	RS	Roadway Subsystem	U2	Conversational data	Short range bursty data communication while in motion, when passing by specific locations at speeds up to 70 mph
62	FMS	Fleet and Freight Management	tax filing, audit data	CVAS	Commercial Vehicle Administration	w	messaging data	
63	FMS	Fleet and Freight	credential application	CVAS	Commercial Vehicle	W	Conversational data,	

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
		Management			Administration		messaging data	
64	FMS	Fleet and Freight Management	information request	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
65	FMS	Fleet and Freight Management	fleet to driver update	CVS	Commercial Vehicle Subsystem	U1t	messaging data	Bursty data
66	FMS	Fleet and Freight Management	Hazmat information	EM	Emergency Management	W	Conversational data, messaging data	
67	FMS	Fleet and Freight Management	route request	ISP	Information Service Provider	W	Conversational data, messaging data	
68	FMS	Fleet and Freight Management	intermod CVO coord	X01	Intermodal Freight Shipper	W	messaging data	
69	FMS	Fleet and Freight Management	intermod CVO coord	X60	Intermodal Freight Depot	W	messaging data	
70	ISP	Information Service Provider	emergency vehicle route	EM	Emergency Management	W	Conversational speech, messaging data	
71	ISP	Information Service Provider	incident information request	EM	Emergency Management	W	Conversational speech, messaging data	
72	ISP	Information Service Provider	route plan	FMS	Fleet and Freight Management	W	messaging data	
73	ISP	Information Service Provider	broadcast information	PIAS	Personal Information Access	W,U1b	messaging data,Broadcast data, Multicast	Free services & services that require subscription
74	ISP	Information Service Provider	trip plan	PIAS	Personal Information Access	W,U1t	Conversational data, Messaging data	Bursty data
75	ISP	Information Service Provider	traveler information	PIAS	Personal Information Access	W,U1t	Broadcast data,Multicast data	Bursty data upon request. Bursty or continuous transmission for one-way systems. Free services and services that require subscription.
76	ISP	Information Service Provider	parking lot data request	PMS	Parking Management	W	messaging data	
77	ISP	Information Service Provider	parking reservations request	PMS	Parking Management	W	messaging data	
78	ISP	Information Service Provider	road network use	PS	Planning Subsystem	W	messaging data	
79	ISP	Information Service Provider	traveler information	RTS	Remote Traveler Support	W	Broadcast data,Multicast data	
80	ISP	Information Service Provider	broadcast information	RTS	Remote Traveler Support	U1b	messaging data,Broadcast data,	Free services and services that require subscription

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
							Multicast	
81	ISP	Information Service Provider	trip plan	RTS	Remote Traveler Support	W	Conversational Data	
82	ISP	Information Service Provider	request for toll schedules	TAS	Toll Administration	W	messaging data	
83	ISP	Information Service Provider	incident notification	TMS	Traffic Management	W	Conversational Data	
84	ISP	Information Service Provider	request for traffic information	TMS	Traffic Management	W	messaging data	
85	ISP	Information Service Provider	logged route plan	TMS	Traffic Management	W	Conversational data, Messaging data	
86	ISP	Information Service Provider	road network use	TMS	Traffic Management	W	messaging data	
87	ISP	Information Service Provider	transit information request	TRMS	Transit Management	W	messaging data	
88	ISP	Information Service Provider	selected routes	TRMS	Transit Management	W	Conversational data, Messaging data	
89	ISP	Information Service Provider	demand responsive transit request	TRMS	Transit Management	W	messaging data	
90	ISP	Information Service Provider	broadcast information	VS	Vehicle	U1b	messaging data, Broadcast data, Multicast	Free services and services that require subscription
91	ISP	Information Service Provider	trip plan	VS	Vehicle	U1t	Conversational data, Messaging data	Bursty data
92	ISP	Information Service Provider	traveler information	VS	Vehicle	U1t, U1b	messaging data, Broadcast data, Multicast	Bursty data
93	ISP	Information Service Provider	intermodal information	X02	Intermodal Transportation Service Provider	W	messaging data	
94	ISP	Information Service Provider	payment request	X21	Financial Institution	W	Conversational data, messaging data	
95	ISP	Information Service Provider	map update request	X23	Map Update Provider	W	messaging data	
96	ISP	Information Service Provider	travel service reservation	X24	Yellow Pages Service Providers	W	messaging data	
97	ISP	Information Service Provider	traffic information	X27	Media	W	messaging data	
98	ISP	Information Service Provider	incident information	X27	Media	W	messaging data	

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
99	ISP	Information Service Provider	traffic information	X28	Media Operator	W	messaging data, Broadcast data, Multicast	
100	ISP	Information Service Provider	incident information	X28	Media Operator	W	messaging data	
101	ISP	Information Service Provider	ISP coord	X31	Other ISP	W	messaging data	
102	PIAS	Personal Information Access	emergency notification	EM	Emergency Management	U1t	Conversational data, messaging data, location data	Minimum delay in data communication for forward and reverse link maybe required. Location data for emergency response
103	PIAS	Personal Information Access	traveler information request	ISP	Information Service Provider	W,U1t	messaging data	Bursty messages, Wireless to PDA. Location data for value added services.
104	PIAS	Personal Information Access	trip request	ISP	Information Service Provider	W,U1t	Conversational Data, Messaging data	Bursty messages, Wireless to PDA
105	PIAS	Personal Information Access	trip confirmation	ISP	Information Service Provider	W,U1t	Conversational Data, Messaging data	Bursty messages. Wireless to PDA
106	PIAS	Personal Information Access	yellow pages request	ISP	Information Service Provider	W,U1t	Conversational Data, Messaging data	Bursty messages, Wireless to PDA
107	PIAS	Personal Information Access	demand responsive transit request	TRMS	Transit Management	U1t	messaging data	Bursty messages
108	PIAS	Personal Information Access	map update request	X23	Map Update Provider	W,U1t	messaging data	Service on request or services by subscription
109	PMS	Parking Management	parking lot reservation confirmation	ISP	Information Service Provider	W	messaging data	
110	PMS	Parking Management	parking availability	ISP	Information Service Provider	W	messaging data	
111	PMS	Parking Management	operational data	PS	Planning Subsystem	W	messaging data	
112	PMS	Parking Management	demand management price change response	TMS	Traffic Management	W	messaging data	
113	PMS	Parking Management	parking availability	TMS	Traffic Management	W	messaging data	
114	PMS	Parking Management	transit parking coordination	TRMS	Transit Management	W	Messaging data	
115	PMS	Parking Management	request tag data	VS	Vehicle	U2	Conversational data	Data transfer while in motion, when passing the specific locations at speeds up to 70 mph
116	PMS	Parking Management	tag update	VS	Vehicle	U2	Conversational data	Data transfer while in motion,

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

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U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
								when passing the specific locations at speeds up to 70 mph
117	PMS	Parking Management	payment request	X21	Financial Institution	W	Conversational data, messaging data	
118	PMS	Parking Management	parking status	X36	Parking Operator	W	messaging data	
119	PMS	Parking Management	parking availability	X37	Parking Service Provider	W	messaging data	
120	PMS	Parking Management	violation notification	X62	Enforcement Agency	W	messaging data	
121	PMS	Parking Management	license request	X64	DMV	W	Messaging data	
122	PS	Planning Subsystem	planning data	TMS	Traffic Management	W	messaging data	
123	PS	Planning Subsystem	map update request	X23	Map Update Provider	W	Messaging data	
124	PS	Planning Subsystem	planning data	X25	Transportation Planners	W	messaging data	
125	RS	Roadway Subsystem	pollution data	EMMS	Emissions Management	W	messaging data	
126	RS	Roadway Subsystem	fault reports	TMS	Traffic Management	W	Conversational data, messaging data	
127	RS	Roadway Subsystem	request for right of way	TMS	Traffic Management	W	Conversational Data	
128	RS	Roadway Subsystem	vehicle probe data	TMS	Traffic Management	W	messaging data	
129	RS	Roadway Subsystem	AHS status	TMS	Traffic Management	W	messaging data	
130	RS	Roadway Subsystem	incident data	TMS	Traffic Management	W	messaging data	
131	RS	Roadway Subsystem	freeway control status	TMS	Traffic Management	w	messaging data	
132	RS	Roadway Subsystem	signal control status	TMS	Traffic Management	W	messaging data	
133	RS	Roadway Subsystem	HOV data	TMS	Traffic Management	W	Messaging data	
134	RS	Roadway Subsystem	signal priority request	TMS	Traffic Management	W	messaging data	
135	RS	Roadway Subsystem	local traffic flow	TMS	Traffic Management	W	messaging data	
136	RS	Roadway Subsystem	AHS control data	VS	Vehicle	U2	messaging data	Data transfer while in motion, when passing the specific locations at speeds up to 70 mph
137	RS	Roadway Subsystem	vehicle signage data	VS	Vehicle	U2	messaging data	Data transfer while in motion, when passing the specific locations at speeds up to 70 mph
138	RS	Roadway Subsystem	intersection status	VS	Vehicle	U2	messaging data	Data transfer while in motion, when passing the specific locations at speeds up to 70 mph
139	RS	Roadway Subsystem	request tag data	VS	Vehicle	U2	Messaging data	

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
140	RS	Roadway Subsystem	grant right of way and/or stop traffic	X29	Multimodal Crossings	W	Conversational data, messaging data	
141	RTS	Remote Traveler Support	emergency notification	EM	Emergency Management	W,U1t	Conversational speech, messaging data, location data	RTS can be a transportable unit. Location data emergency response.
142	RTS	Remote Traveler Support	yellow pages request	ISP	Information Service Provider	W	Conversational data, Messaging Data	
143	RTS	Remote Traveler Support	trip request	ISP	Information Service Provider	W	Conversational Data	
144	RTS	Remote Traveler Support	traveler information request	ISP	Information Service Provider	W	messaging data	
145	RTS	Remote Traveler Support	demand responsive transit request	ISP	Information Service Provider	W	messaging data	
146	RTS	Remote Traveler Support	emergency notification	TRMS	Transit Management	W	Conversational data, Messaging Data	
147	RTS	Remote Traveler Support	transit request	TRMS	Transit Management	W	messaging data	
148	RTS	Remote Traveler Support	traveler information request	TRMS	Transit Management	W	messaging data	
149	RTS	Remote Traveler Support	map update request	X23	Map Update Provider	W	messaging data	
150	TAS	Toll Administration	toll schedules	ISP	Information Service Provider	W	messaging data	
151	TAS	Toll Administration	operational data	PS	Planning Subsystem	W	messaging data	
152	TAS	Toll Administration	toll instructions	TCS	Toll Collection	W	messaging data	
153	TAS	Toll Administration	demand management price change response	TMS	Traffic Management	W	messaging data	
154	TAS	Toll Administration	probe data	TMS	Traffic Management	W	messaging data	
156	TAS	Toll Administration	payment request	X21	Financial Institution	W	messaging data	
157	TAS	Toll Administration	toll revenues and summary reports	X44	Toll Service Provider	W	messaging data	
158	TAS	Toll Administration	violation notification	X62	Enforcement Agency	W	messaging data	
159	TAS	Toll Administration	license request	X64	DMV	W	messaging data	
160	TCS	Toll Collection	toll transactions	TAS	Toll Administration	W	messaging data	
161	TCS	Toll Collection	tag update	VS	Vehicle	U2	Conversational Data	Data communication while passing by specific locations at speeds up to 70 mph
162	TCS	Toll Collection	request tag data	VS	Vehicle	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
163	TMS	Traffic Management	incident information request	EM	Emergency Management	W	Messaging data	
164	TMS	Traffic Management	incident notification	EM	Emergency Management	W	Messaging data	
165	TMS	Traffic Management	pollution state data request	EMMS	Emissions Management	W	messaging data	
166	TMS	Traffic Management	traffic information	ISP	Information Service Provider	W	messaging data	
167	TMS	Traffic Management	parking instructions	PMS	Parking Management	W	messaging data	
168	TMS	Traffic Management	demand management price change request	PMS	Parking Management	W	messaging data	
169	TMS	Traffic Management	operational data	PS	Planning Subsystem	W	messaging data	
170	TMS	Traffic Management	freeway control data	RS	Roadway Subsystem	W	messaging data	
171	TMS	Traffic Management	signal control data	RS	Roadway Subsystem	W	messaging data	
172	TMS	Traffic Management	AHS control information	RS	Roadway Subsystem	W	messaging data	
173	TMS	Traffic Management	signage data	RS	Roadway Subsystem	W	messaging data	
174	TMS	Traffic Management	demand management price change request	TAS	Toll Administration	W	messaging data	
175	TMS	Traffic Management	traffic information	TRMS	Transit Management	W	messaging data	
176	TMS	Traffic Management	demand management price change request	TRMS	Transit Management	W	messaging data	
177	TMS	Traffic Management	signal priority status	TRMS	Transit Management	W	Conversational data, messaging data	
178	TMS	Traffic Management	event confirmation	X19	Event Promoters	W	messaging data	
179	TMS	Traffic Management	map update request	X23	Map Update Provider	W	messaging data	
180	TMS	Traffic Management	TMC coord.	X35	Other TM	W	messaging data	
181	TMS	Traffic Management	violation notification	X62	Enforcement Agency	W	messaging data	
182	TMS	Traffic Management	license request	X64	DMV	W	messaging data	
183	TRMS	Transit Management	security alarms	EM	Emergency Management	W	Conversational data, messaging data, location data	Location data for emergency response
184	TRMS	Transit Management	demand responsive transit plan	ISP	Information Service Provider	W	Conversational data, messaging data	
185	TRMS	Transit Management	transit and fare schedules	ISP	Information Service Provider	W	messaging data	
186	TRMS	Transit Management	transit request confirmation	ISP	Information Service Provider	W	messaging data	
187	TRMS	Transit Management	demand responsive transit route	PIAS	Personal Information Access	W,U1t	messaging data	Bursty data

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
188	TRMS	Transit Management	parking lot transit response	PMS	Parking Management	W	messaging data, Broadcast data, Multicast	
189	TRMS	Transit Management	operational data	PS	Planning Subsystem	W	messaging data	
190	TRMS	Transit Management	traveler information	RTS	Remote Traveler Support	W	messaging data, Multicast data	
191	TRMS	Transit Management	transit and fare schedules	RTS	Remote Traveler Support	W	messaging data, Multicast data	
192	TRMS	Transit Management	emergency acknowledge	RTS	Remote Traveler Support	W	Conversational data, messaging data	
193	TRMS	Transit Management	request for transit signal priority	TMS	Traffic Management	W	messaging data	
194	TRMS	Transit Management	demand management price change response	TMS	Traffic Management	W	messaging data	
195	TRMS	Transit Management	emergency acknowledge	TRVS	Transit Vehicle Subsystem	U1t	Conversational data, messaging data	Minimum delay may be required
196	TRMS	Transit Management	driver instructions	TRVS	Transit Vehicle Subsystem	U1t	messaging data	
197	TRMS	Transit Management	bad tag list	TRVS	Transit Vehicle Subsystem	U1t	messaging data	Bursty data
198	TRMS	Transit Management	request for vehicle measures	TRVS	Transit Vehicle Subsystem	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
199	TRMS	Transit Management	schedules, fare info request	TRVS	Transit Vehicle Subsystem	U1t	messaging data	Bursty data
200	TRMS	Transit Management	traveler information	TRVS	Transit Vehicle Subsystem	U1t	messaging data	Bursty data
201	TRMS	Transit Management	route assignment	TRVS	Transit Vehicle Subsystem	U1t,U2	messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
202	TRMS	Transit Management	intermodal information	X02	Intermodal Transportation Service Provider	W	messaging data	
203	TRMS	Transit Management	payment request	X21	Financial Institution	W	Conversational data, messaging data	
204	TRMS	Transit Management	map update request	X23	Map Update Provider	W	messaging data	
205	TRMS	Transit Management	TRMS coord	X33	Other TRM	W	messaging data	
206	TRMS	Transit Management	camera control	X42	Secure Area	W	Conversational data,	

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
					Environment		messaging data	
207	TRMS	Transit Management	violation notification	X62	Enforcement Agency	W	messaging data	
208	TRVS	Transit Vehicle Subsystem	local signal priority request	RS	Roadway Subsystem	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
209	TRVS	Transit Vehicle Subsystem	transit vehicle conditions	TRMS	Transit Management	U1t,U2	messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
210	TRVS	Transit Vehicle Subsystem	vehicle probe data	TRMS	Transit Management	U1t	Conversational data, messaging data, location data	Bursty data
211	TRVS	Transit Vehicle Subsystem	traveler information request	TRMS	Transit Management	U1t	Conversational data, messaging data	
212	TRVS	Transit Vehicle Subsystem	emergency notification	TRMS	Transit Management	U1t	messaging data	
213	TRVS	Transit Vehicle Subsystem	fare and payment status	TRMS	Transit Management	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
214	TRVS	Transit Vehicle Subsystem	transit vehicle passenger and use data	TRMS	Transit Management	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
215	TRVS	Transit Vehicle Subsystem	traveler advisory request	VS	Vehicle	W	Messaging data	
216	VS	Vehicle	cargo data request	CVS	Commercial Vehicle Subsystem	W	Messaging data	
217	VS	Vehicle	emergency notification	EM	Emergency Management	U1t	Conversational speech, messaging data, location data	Bursty data and live speech. Location data for emergency response
218	VS	Vehicle	vehicle location	EVS	Emergency Vehicle Subsystem	W	Broadcast data	
219	VS	Vehicle	traveler information request	ISP	Information Service Provider	U1t	Conversational data, messaging data	
220	VS	Vehicle	trip request	ISP	Information Service Provider	U1t	Conversational data, messaging data	Busrty data
221	VS	Vehicle	trip confirmation	ISP	Information Service Provider	U1t	Conversational data, messaging data	Busrty data
222	VS	Vehicle	vehicle probe data	ISP	Information Service	U1t	messaging data, location	Busrty data

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
					Provider		data	
223	VS	Vehicle	yellow pages request	ISP	Information Service Provider	U1t	Conversational data, messaging data	
224	VS	Vehicle	tag data	PMS	Parking Management	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
225	VS	Vehicle	AHS vehicle data	RS	Roadway Subsystem	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
226	VS	Vehicle	vehicle probe data	RS	Roadway Subsystem	U2	Messaging Data	Data communication while passing by specific locations at speeds up to 70 mph
227	VS	Vehicle	tag data	TCS	Toll Collection	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
228	VS	Vehicle	vehicle location	TRVS	Transit Vehicle Subsystem	W	Broadcast data	
229	VS	Vehicle	vehicle control	X03	Basic Vehicle	W	Conversational Data	
230	VS	Vehicle	map update request	X23	Map Update Provider	U1t	messaging data	Busrtty data
231	X01	Intermodal Freight Shipper	intermod CVO coord	FMS	Fleet and Freight Management	W	messaging data	
232	X02	Intermodal Transportation Service Provider	intermodal information	ISP	Information Service Provider	W	messaging data	
233	X02	Intermodal Transportation Service Provider	intermodal information	TRMS	Transit Management	W	messaging data	
234	X03	Basic Vehicle	vehicle measures	VS	Vehicle	W	Broadcast data	
235	X08	Commercial Vehicle	vehicle measures	CVS	Commercial Vehicle Subsystem	W	Broadcast data	
236	X10	CVO Inspector	CVC override mode	CVCS	Commercial Vehicle Check	U2	Conversational data, messaging data	
237	X13	E911 or ETS	incident information	EM	Emergency Management	W	Conversational data conversational speec, location data	Location data for emergency response
238	X19	Event Promoters	event plans	TMS	Traffic Management	W	messaging data, Multicast data	
239	X21	Financial Institution	transaction status	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
240	X21	Financial Institution	transaction status	ISP	Information Service	W	Conversational data,	

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
					Provider		messaging data	
241	X21	Financial Institution	transaction status	PMS	Parking Management	W	Conversational data, messaging data	
242	X21	Financial Institution	transaction status	TAS	Toll Administration	W	Conversational data, messaging data	
243	X21	Financial Institution	transaction status	TRMS	Transit Management	W	Conversational data, messaging data	
244	X22	Government Administrators	regulations	CVAS	Commercial Vehicle Administration	W	messaging data, Multicast data	
245	X23	Map Update Provider	map updates	EM	Emergency Management	W	messaging data, Multicast data	
246	X23	Map Update Provider	map updates	EMMS	Emissions Management	W	messaging data	
247	X23	Map Update Provider	map updates	ISP	Information Service Provider	W	messaging data, Multicast data	
248	X23	Map Update Provider	map updates	PIAS	Personal Information Access	W,U1t	messaging data, Multicast data	Service on request or by subscription
249	X23	Map Update Provider	map updates	PS	Planning Subsystem	W	messaging data, Broadcast data, Multicast	
250	X23	Map Update Provider	map updates	RTS	Remote Traveler Support	W	messaging data	
251	X23	Map Update Provider	map updates	TMS	Traffic Management	W	messaging data, Multicast data	
252	X23	Map Update Provider	map updates	TRMS	Transit Management	W	messaging data, Multicast data	
253	X23	Map Update Provider	map updates	VS	Vehicle	U1t	messaging data, Multicast data	Service on request or by subscription
254	X24	Yellow Pages Service Providers	travel service info	ISP	Information Service Provider	W	messaging data	
255	X25	Transportation Planners	planning data	PS	Planning Subsystem	W	messaging data	
256	X27	Media	external reports	ISP	Information Service Provider	W	messaging data, Multicast data	
257	X28	Media Operator	incident notification	ISP	Information Service Provider	W	messaging data, Broadcast data, Multicast	
258	X29	Multimodal Crossings	right of way preemption request	RS	Roadway Subsystem	W	Conversational data, messaging data	
259	X29	Multimodal Crossings	request for right of way	RS	Roadway Subsystem	W	Conversational data,	

Table A.5-1 Data Flow – Communications Service Mapping (Cont'd)

W = Wireline

U1b = Wireless wide area one-way broadcast

U1t = Wireless wide area interface

U2 = Short range (close proximity) vehicle to roadside wireless interface

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
260	X30	Other EM	emergency coordination	EM	Emergency Management	W	messaging data Conversational data, messaging data	
261	X31	Other ISP	ISP coord	ISP	Information Service Provider	W	messaging data	
262	X33	Other TRM	TRMS coord	TRMS	Transit Management	W	messaging data	
263	X35	Other TM	TMC coord.	TMS	Traffic Management	W	messaging data	
264	X37	Parking Service Provider	request for performance data	PMS	Parking Management	W	messaging data	
265	X51	Transit Vehicle	vehicle measures	TRVS	Transit Vehicle Subsystem	W	Broadcast data	
266	X58	Weather Service	weather information	ISP	Information Service Provider	W	messaging data, Broadcast data, Multicast	
267	X58	Weather Service	weather information	TMS	Traffic Management	W	messaging data, Broadcast data, Multicast	
268	X59	Other CVAS	CVAS information exchange	CVAS	Commercial Vehicle Administration	W	messaging data	
269	X59	Other CVAS	credentials and safety information response	CVAS	Commercial Vehicle Administration	W	messaging data	
270	X60	Intermodal Freight Depot	intermod CVO coord	FMS	Fleet and Freight Management	W	messaging data	
271	X64	DMV	registration	CVAS	Commercial Vehicle Administration	W	messaging data	
272	X64	DMV	vehicle characteristics	PMS	Parking Management	W	Messaging data	
273	X64	DMV	registration	TAS	Toll Administration	W	messaging data	
274	X64	DMV	registration	TMS	Traffic Management	W	messaging data	
275	X65	CVO Information Requestor	credentials and safety information request	CVAS	Commercial Vehicle Administration	W	messaging data	

APPENDIX B ARCHITECTURE INTERCONNECT DIAGRAMS

LEVEL 1

Using the AID template and the Data Flow - Communication Services Mapping table presented in Appendix A, a sample set of the data flows are represented in an Architecture Interconnect Diagram (AID) format. Each AID may represent more than one data flow. Whereas many of the AIDs support messaging and conversational data, in many cases they can also be supported by conversational speech. In fact, near-term deployments of applications like pre-trip planning or en-route driver advisories will probably disseminate information verbally rather than via bit streams. Thus providing for this in the analysis supports both rural deployments, and early deployment in any location. In rural areas providing new infrastructure will most likely be expensive until enough other demand is reached or older existing equipment must be replaced.

The substantiation for the operation mode is based on the nature of the data flow (*e.g.*, anticipated frequency of use, message length, qualitative rationale). The operation mode was refined and calibrated with information from Section 6, Data Loading Analysis.

Figures B-1 through B-17 are a sample set of the AIDs for the inter-entity links, indicating the physical medium, wireline (*w*) or wireless (*u*₁, *u*₂, *u*₃) and the mode of operation (*e.g.*, circuit, packet) and carrying forward the service types (conversational speech, conversational data, messaging data, broadcast data and/or multicast data) from the Data Flow - Communication Services Mapping Table. The figures show the flow from the left entity to the right entity, unless specifically indicated for that flow (which occurs when there are flows in both directions).

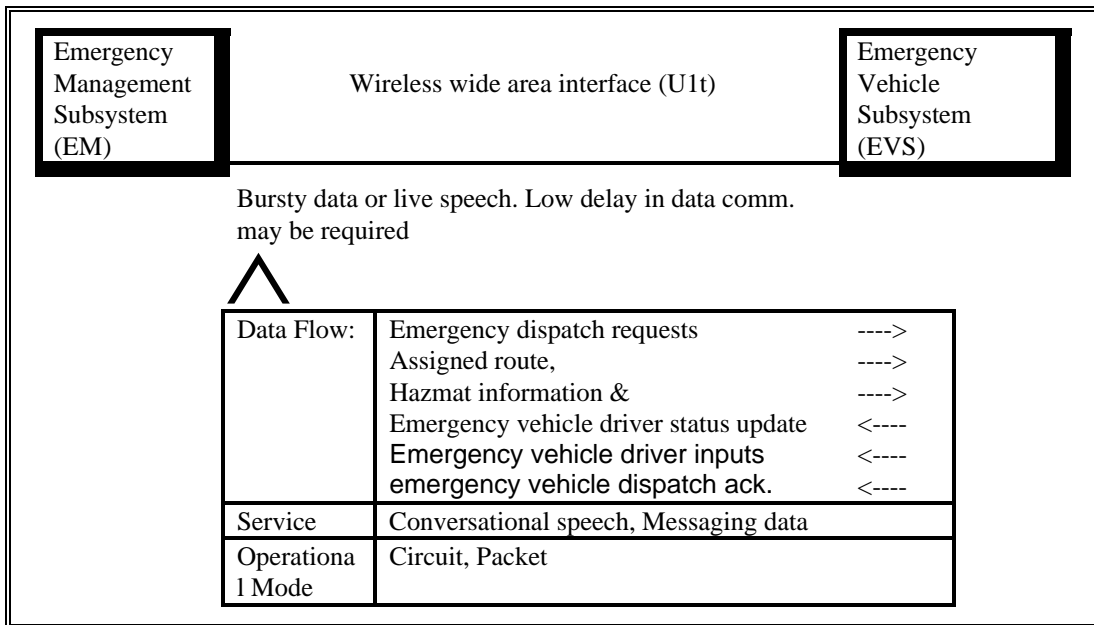


Figure B-1 First Level EM - EVS AID

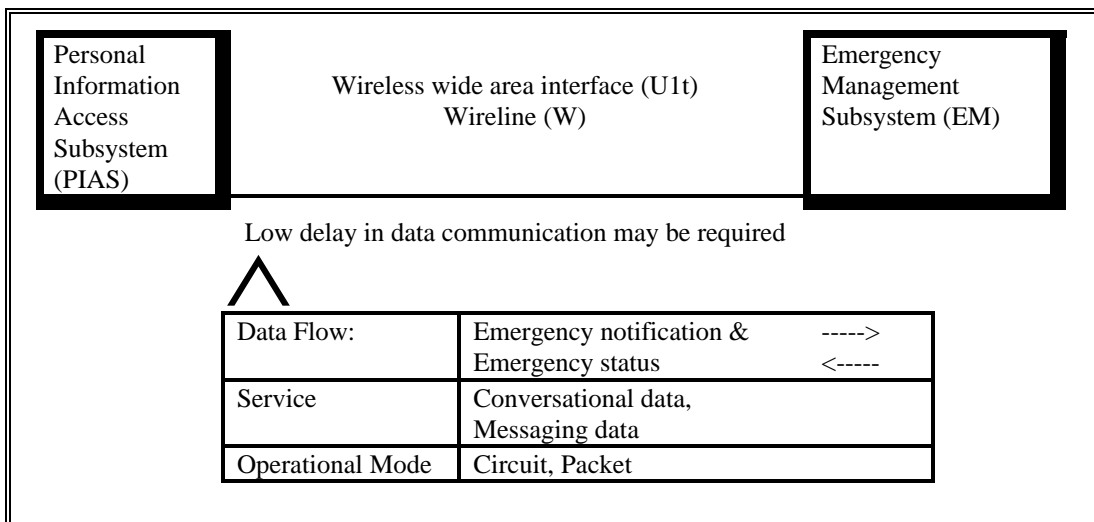


Figure B-2 First Level PIAS-EM AID

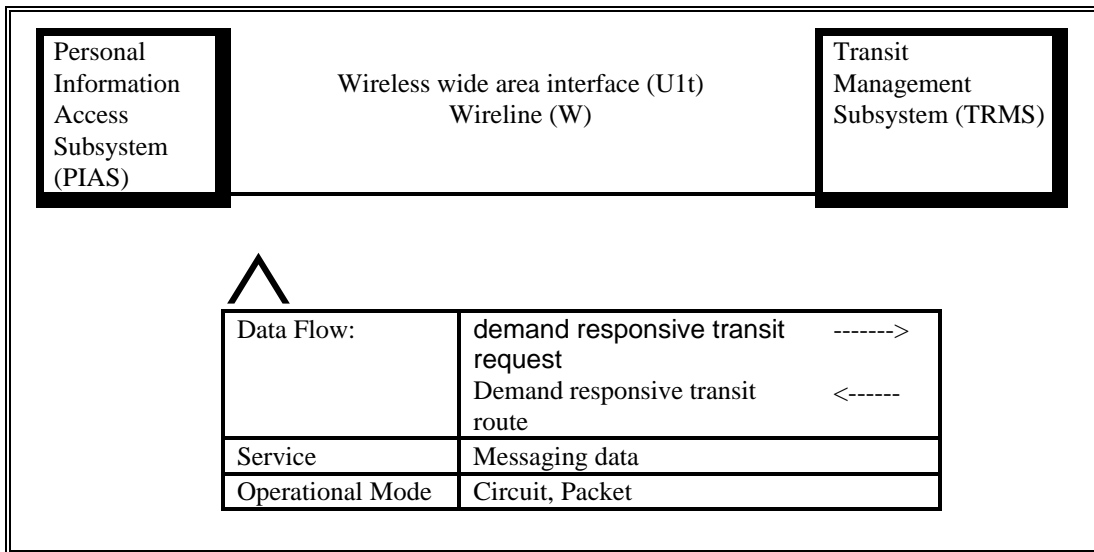


Figure B-3 First Level PIAS-TRMS AID

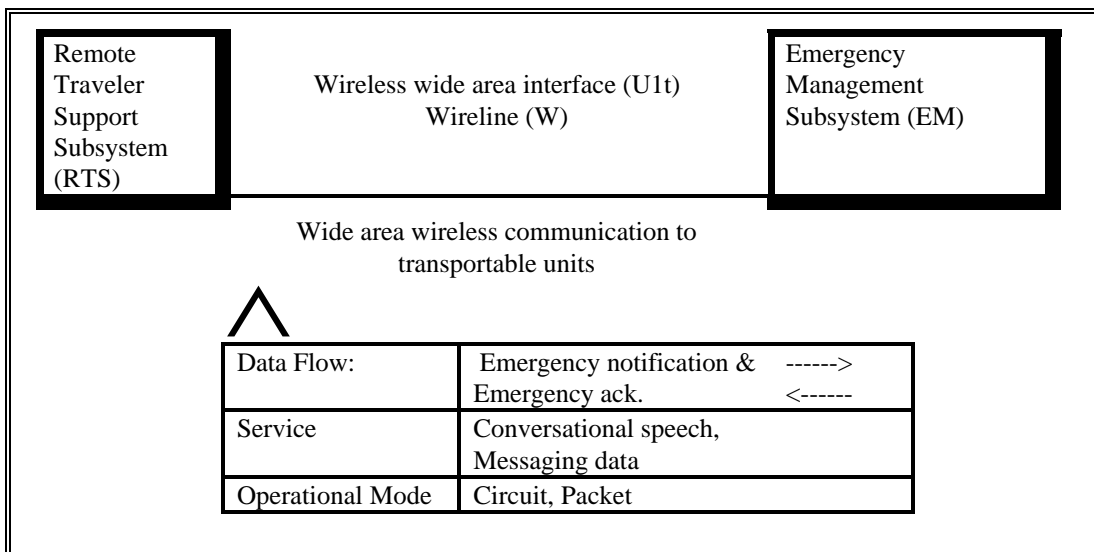


Figure B-4 First Level RTS-EM AID

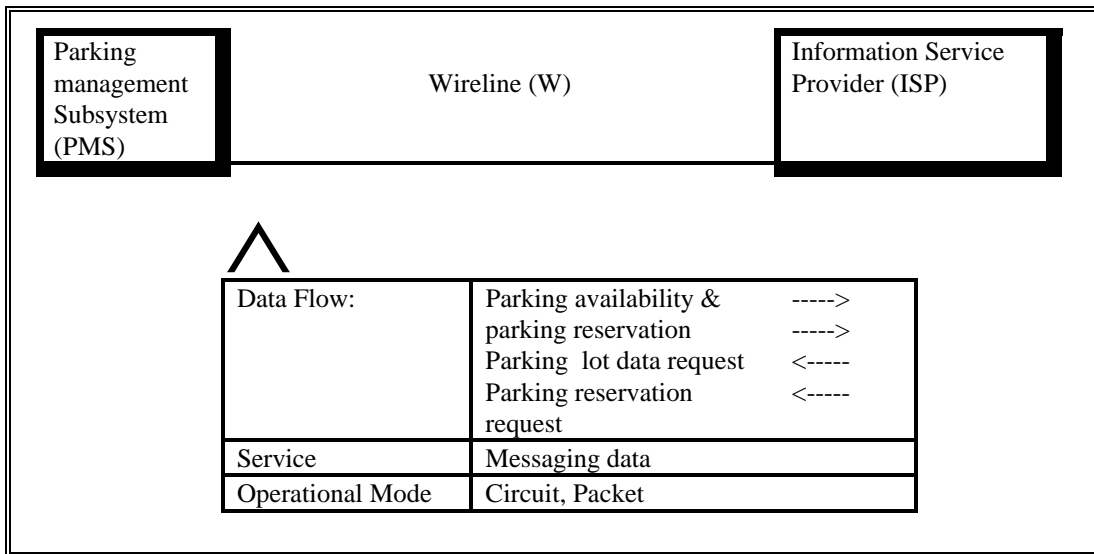


Figure B-5 First Level PMS-ISP AID

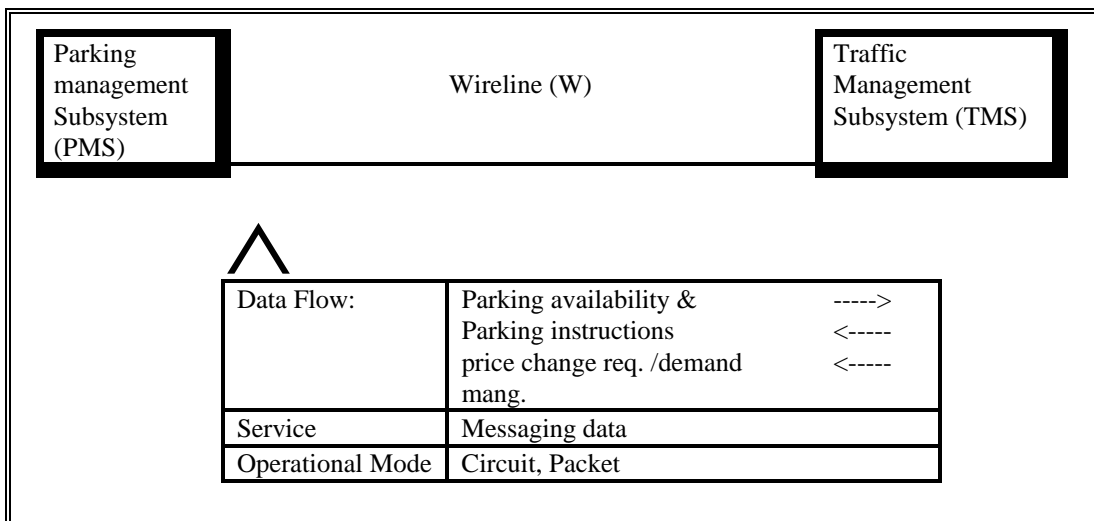


Figure B-6 First Level PMS-TMS AID

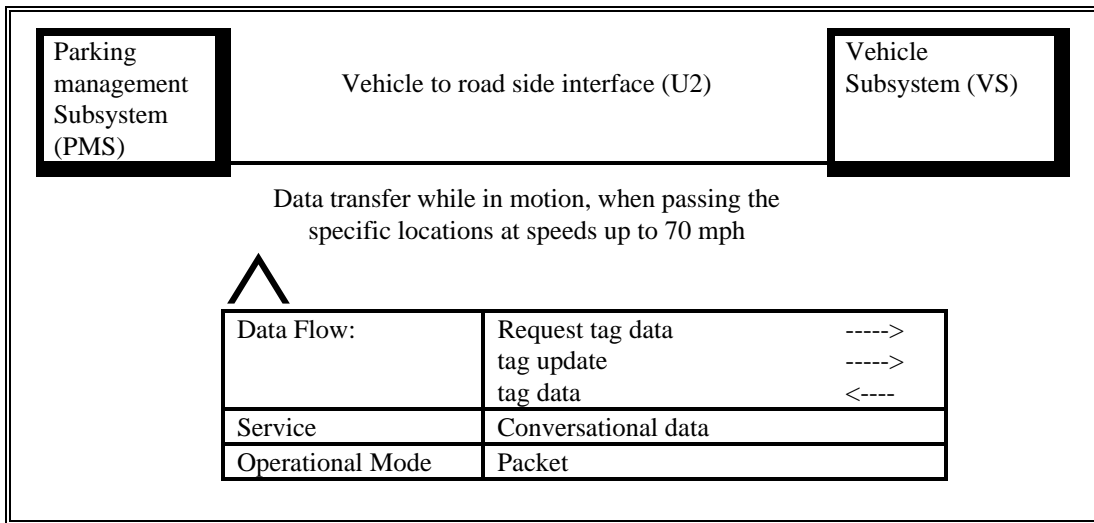


Figure B-7 First Level PMS-VS AID

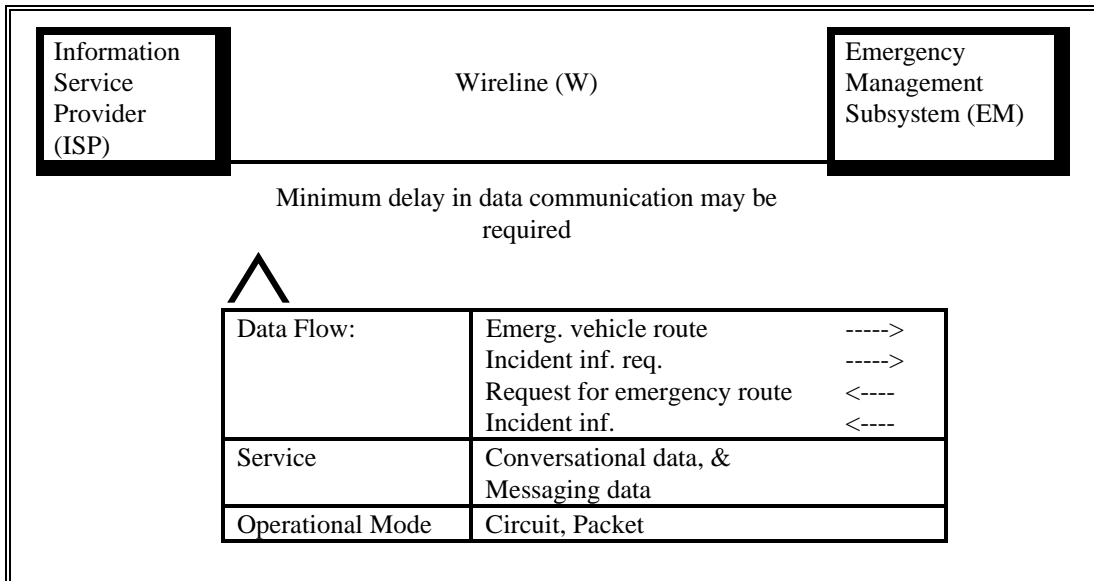


Figure B-8 First Level ISP-EM AID

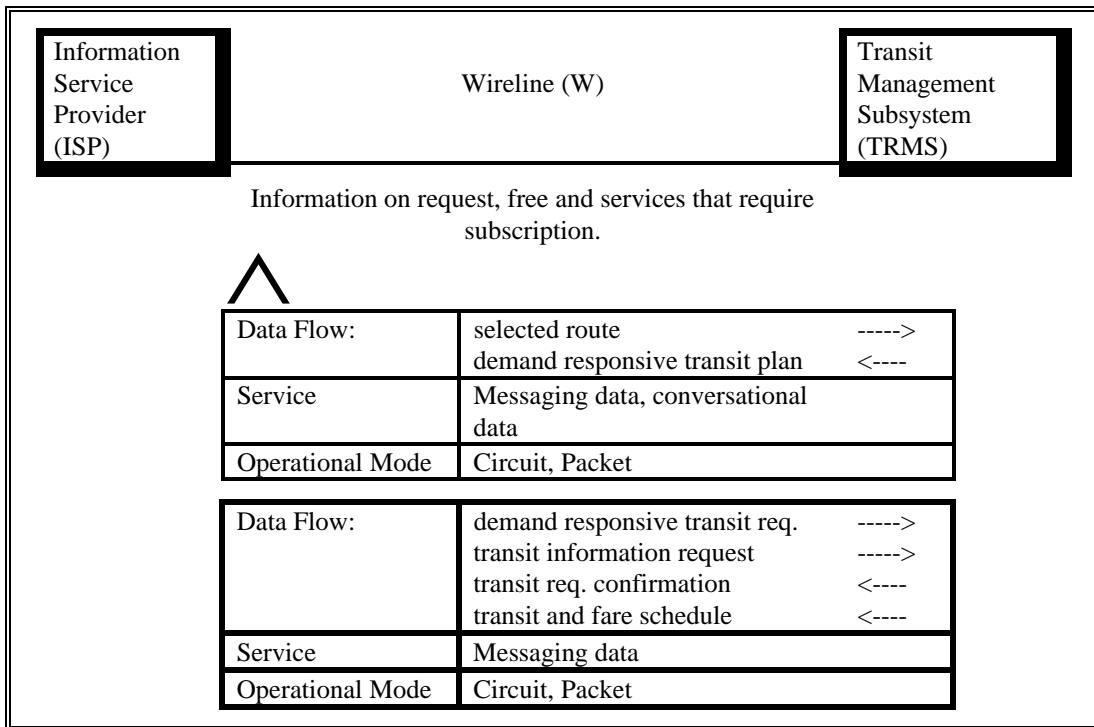


Figure B-9 First Level ISP-TRMS AID

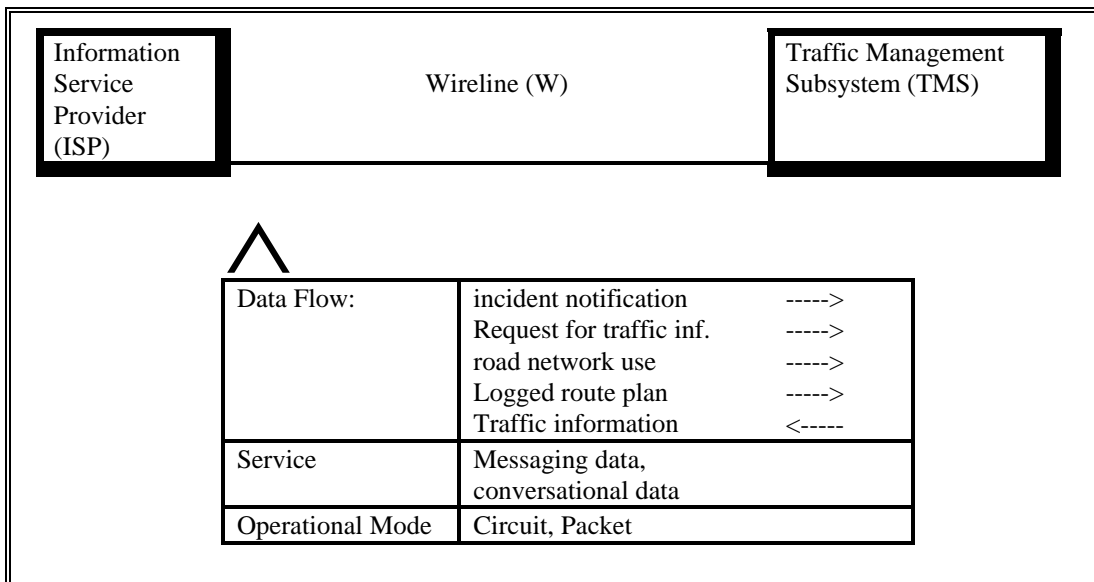


Figure B-10 First Level ISP-TMS AID

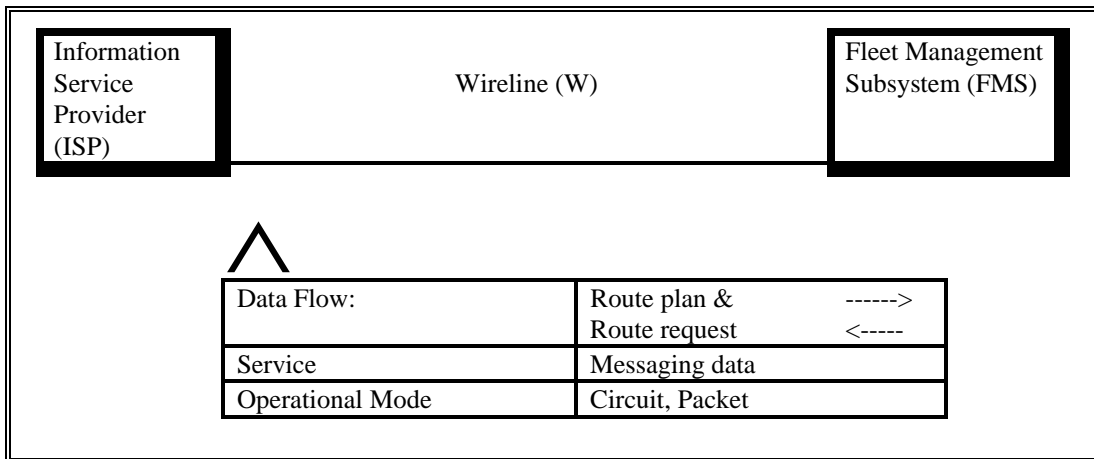


Figure B-11 First Level ISP-FMS AID

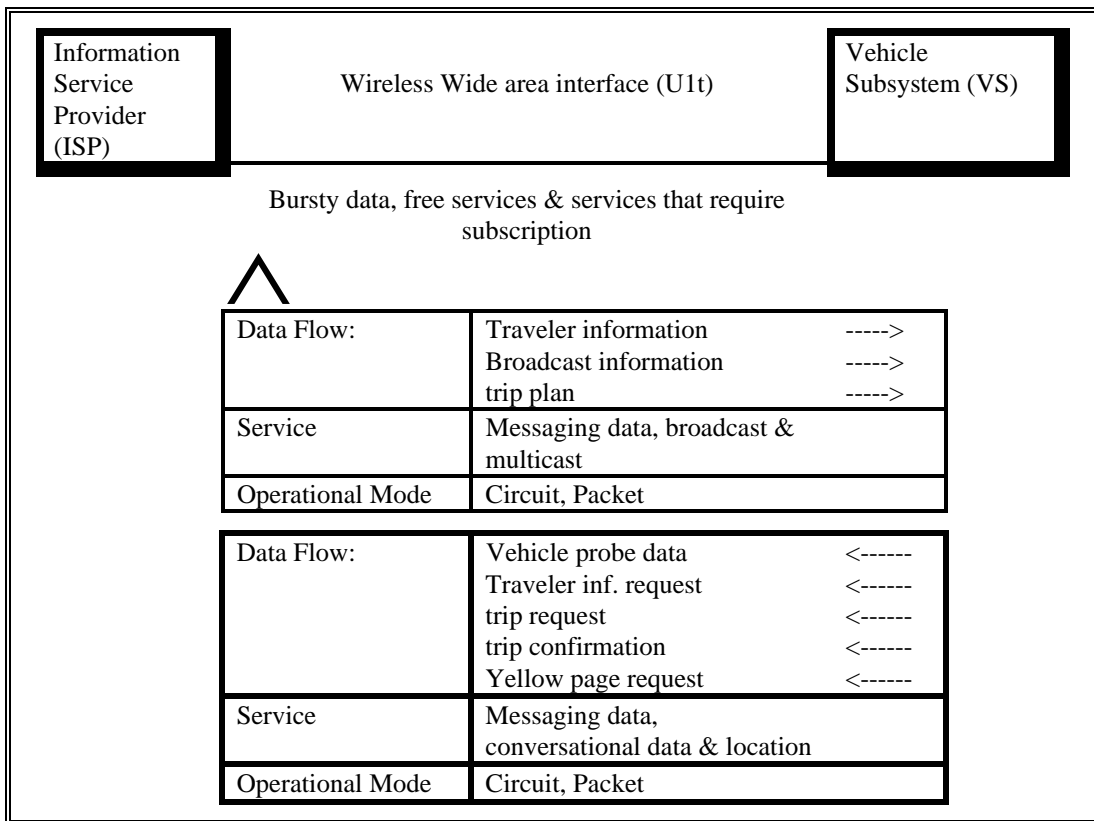


Figure B-12 First Level ISP-VS AID

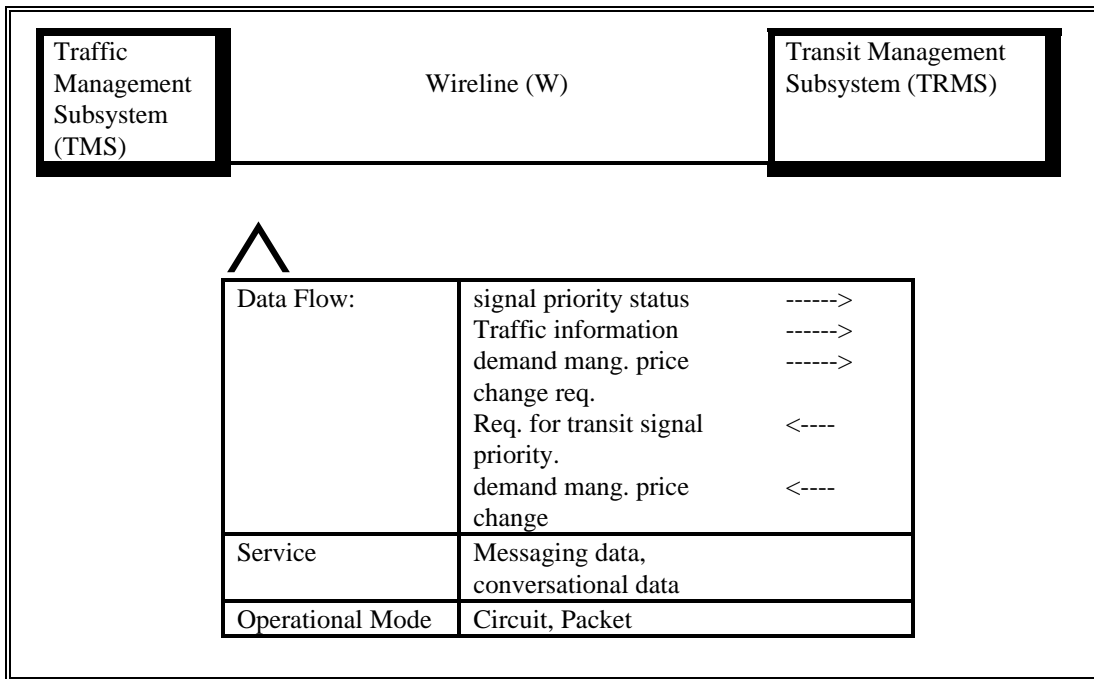


Figure B-13 First Level TMS-TRMS AID

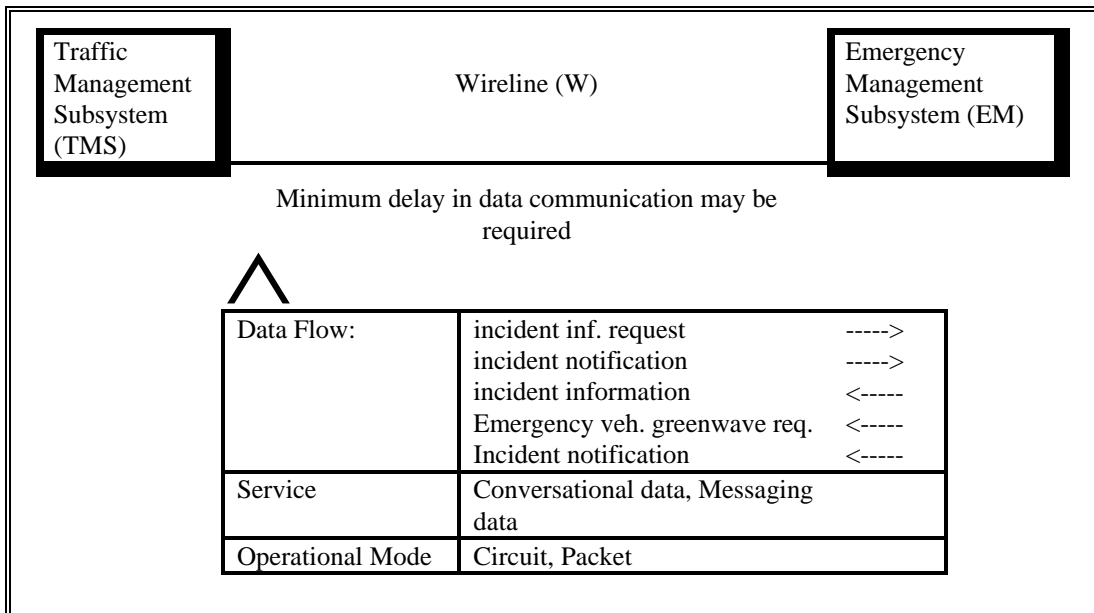


Figure B-14 First Level TMS-EM AID

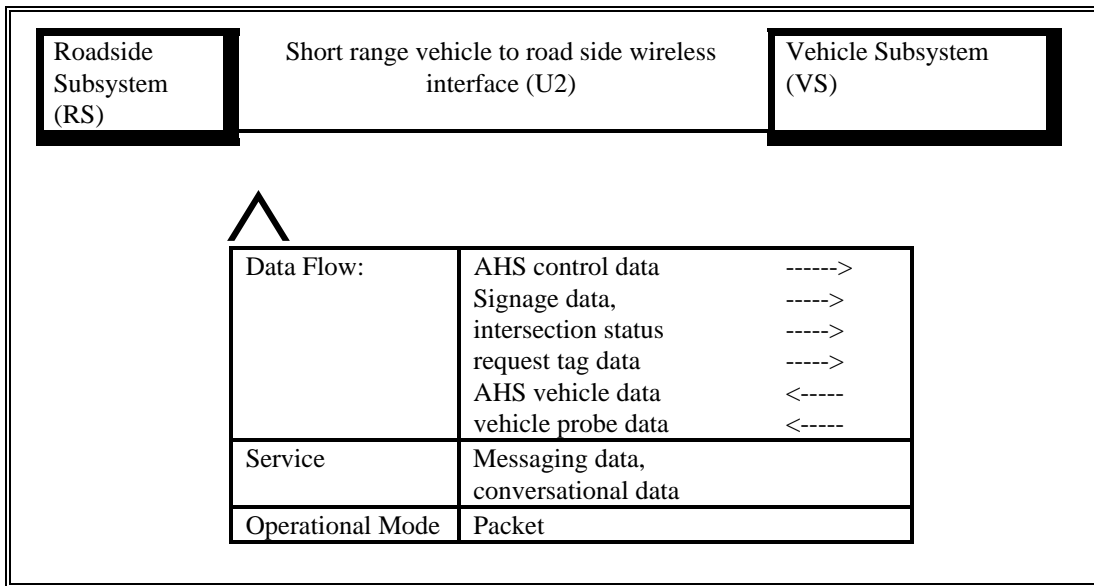


Figure B-15 First Level RS-VS AID

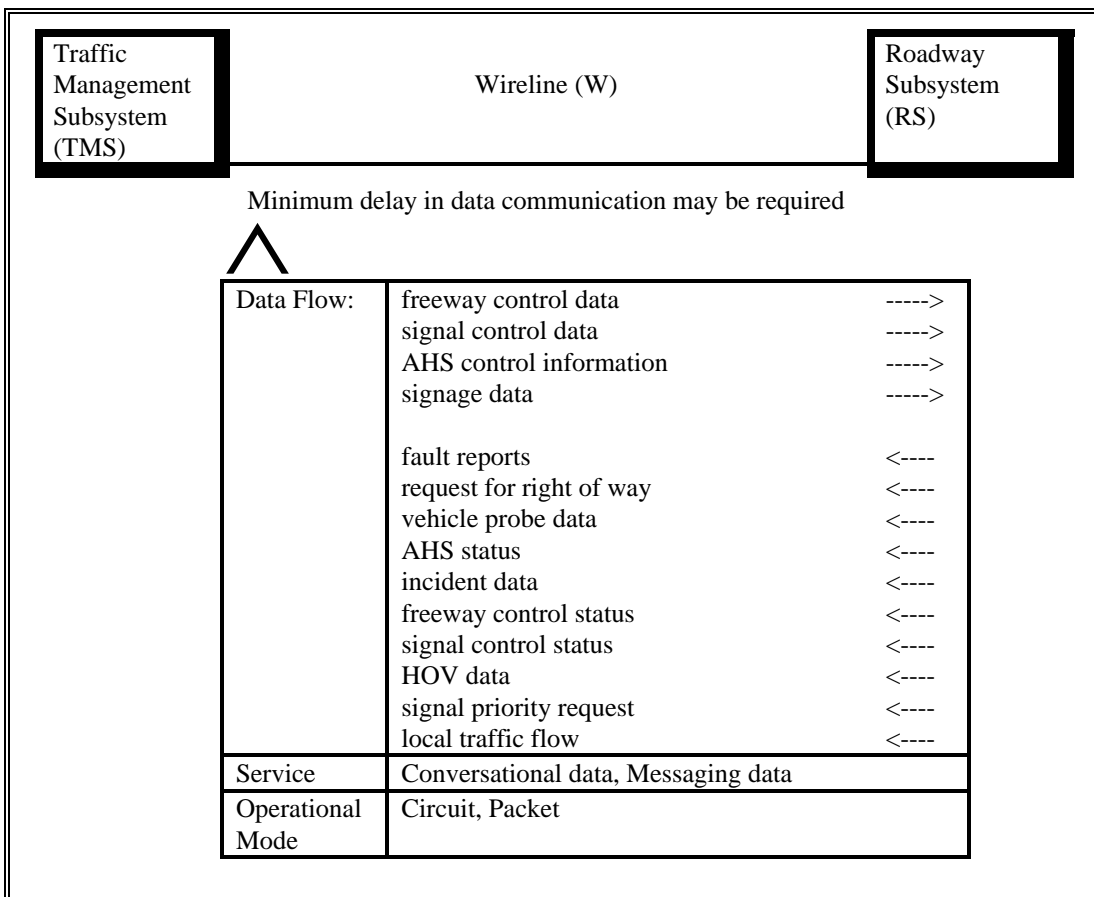


Figure B-16 First Level TMS-RS AID

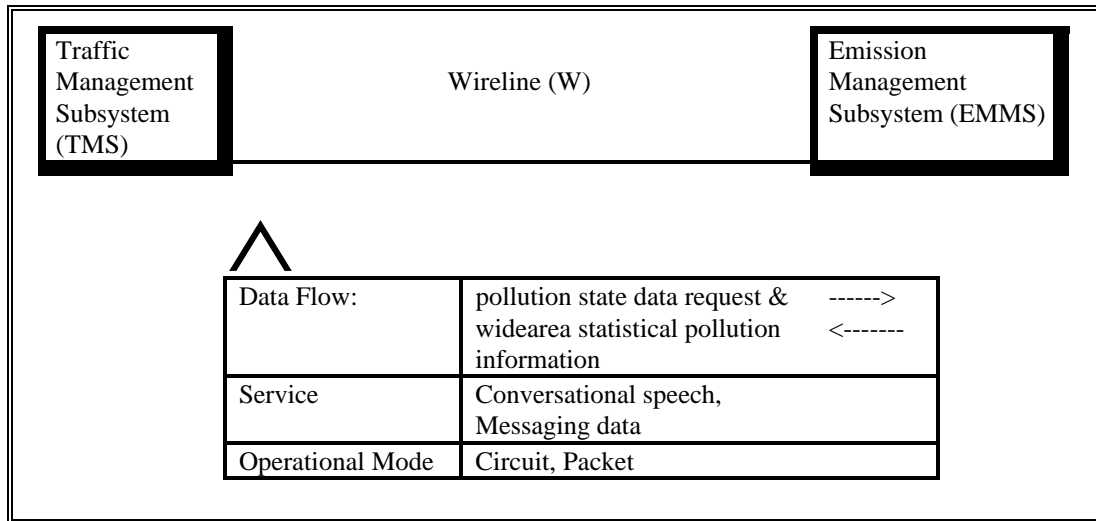


Figure B-17 First Level TMS-EMMS AID

APPENDIX C COMMUNICATION ARCHITECTURE RENDITIONS AND APPLICABLE TECHNOLOGIES

Section C.1 of this appendix provides information that represents the next step in the communications architecture design process – the development of the Communication Architecture Renditions. This activity is denoted as the highlighted block in Figure C.0-1. The architecture renditions are essentially examples of how to provide connections between users based on the communications network reference model and the evaluations of feasible implementations. In addition, to save the re-listing of the renditions, each rendition is combined with the listing of the data flows supported by that rendition. This effectively provides a map between the renditions and the Architecture Interconnect Diagrams (AIDs). Section C.2 provides an example of mapping applicable communication technologies to the renditions.

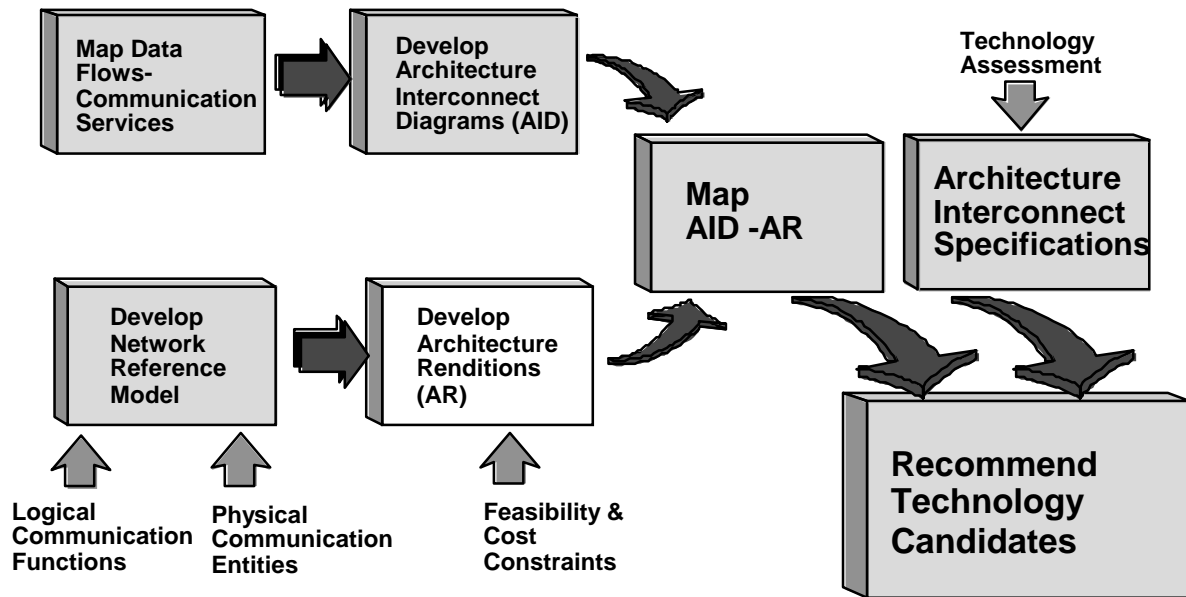


Figure C.0-1 Communications Architecture Development Process – Develop Architecture Renditions

C.1 Format/Purpose

The previous sections have identified the physical entities and the communication services required between them. The task now is to show how user-to-user communication paths are built up from combinations of the identified wireline and wireless links, and to show that the user's needs are met by the identified communication services. This is accomplished by establishing a set of renditions which illustrate the connectivities provided by w and u links. A Level 1 rendition is generated for each of the possible interconnections between these services, except three which do not meet the needs of the architecture. Again the Level 0 Rendition, which shows the full connectivity between users over multiple links, appears before the Level 1 renditions from which it was developed.

C.1.1 Level 0 Rendition

The Level 0 rendition (Figure C.1-1) represents a composition of all the renditions to reflect the combined needs of the architecture. The left side shows a general user with any one or all four possible communication links and how those links connect the user to other users.

The Level 0 Rendition shows a generic user communicating to another user over one of the four communication types (w, u_1, u_2, u_3), where the medium/long and short distance radio based communication (u_1 and u_2 , respectively) travels through a base station (the wireline almost without exception will pass through a central office or at least a user concentrator/switch) and the vehicle-to-vehicle radio (u_3) uses no intermediary.

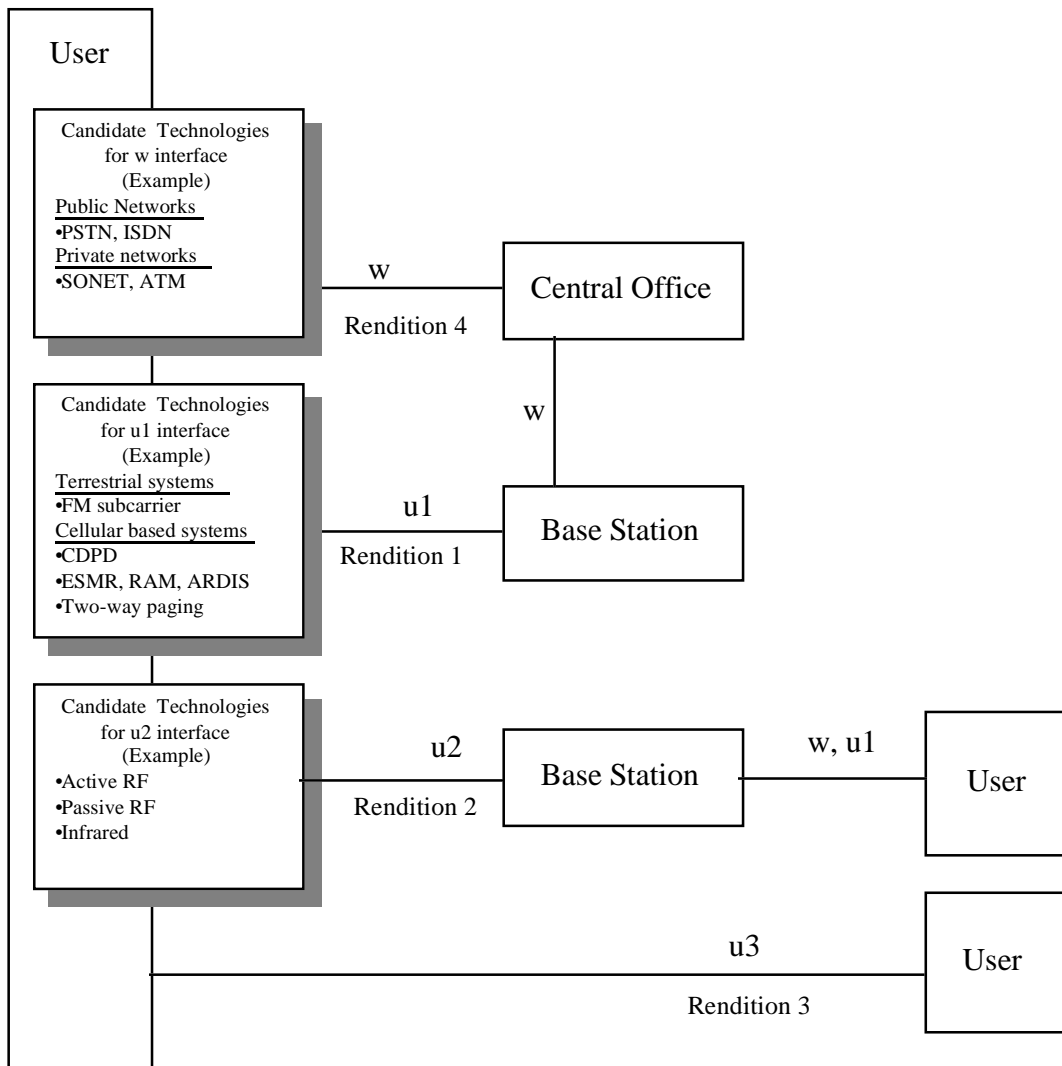


Figure C.1-1 Level 0 Rendition

C.1.2 Level 1 Rendition

Figure C.1-2 illustrates the interaction between the users and the underlying communication architecture. Given the choice of communication services and operation modes (*i.e.*, circuit versus packet versus non-switched), several renditions of this general model are possible (these may be supported by a single communication infrastructure).

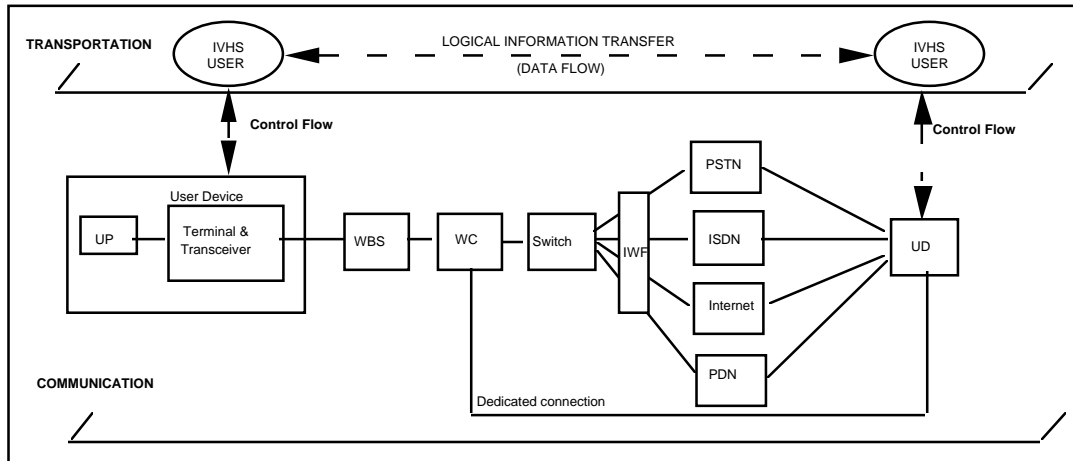


Figure C.1-2 Communication Architecture – Transportation Layer Interaction

The communication architecture in Figure C.1-2 shows multiple functions necessary to deliver data from or to a mobile ITS user to or from a stationary user, respectively. Because the path from stationary user to stationary user makes use of the wireline component in all but a few data flows, the best path makes use of the existing infrastructure provided by public communications service providers such as the local Telco in all but a few exceptional locations. In those locations ITS users may deploy their own dedicated system; even then that connection will be interconnected to, and therefore appear as an extension of, the existing public system.

To simplify the presentation, the end-to-end model represented by Figure C.1-2 is broken into those types which are of direct interest to the ITS architecture: the u_1 , u_2 , u_3 , and w , those at each end of the link for which the interface to the communications service provider is not transparent to the system. Thus four renditions are given, one for each of the u and w types of link. The gathering deployment of digital cellular and other digital radio technologies bolsters the assumption that the tetherless (mobile) user will have a digital connection to other users connected to the group of base stations and, in most locations, to the local communications service provider.

Rendition 1: (u_1)

The u_1 link is required to provide (part way) service between tetherless and both other tetherless users and stationary users. The u_1 link includes the two-way wireless link u_{1t} and the broadcast link u_{1b} . As shown in Figure C.1-3a, the u_{1t} link end-to-end service for tetherless users connected to the same base station or base stations with dedicated connections. In the near term this is mostly an analog service but evolving to digital over the next few years. The service may use one or more of the technologies listed in Appendix D, Technology Survey and Assessment. When users have different technologies not supported by the same base station, the public switched network (PSTN) typically provides the connection between the different base stations. For communication between tetherless and stationary users, the u_{1t} link connects the tetherless user to the base station and the public telco. The wireline portion of the connection is considered secondary to the wireless link in its criticality.

u_{1t} interconnection between tetherless users and stationary users would be digital except in some instances (including rural where the local telco service has not yet been digitized). In that case, while the fixed portion of the network supports circuit-mode operation, it cannot exchange digital signals. A modem bank interconnected to the Mobile Switching Center (MSC) initiates a call setup to the target application. A modem at the target user converts the signal to digital data. A call from a stationary user is routed through the telco or one of the Internet-like networks to the base station in the reverse process and then a channel, either circuit-switched (primarily for voice or large messages) or packet-switched (primarily for data but also voice) to the tetherless user is identified. Thus, the logical connection between the two users in the transportation plane is satisfied. Because of the short nature of all currently identified messages, most will use packet switching whenever that option is available. This rendition supports the data flows, listed in Table C.1-1a.

Figure C.1-3b depicts the rendition for u_{1b} . This link can support low rate one-way wireless data services. It uses broadcast services which include paging and FM subcarrier technology for transmitting data to subscribers over the paging and FM frequency channels. From Figure C.1-3b, the broadcast data is processed (in the message processor) and distributed to the selected paging or FM broadcast stations. Broadcast stations encode and modulate the data using paging or FM subcarrier modulation format, as described in Section 7.

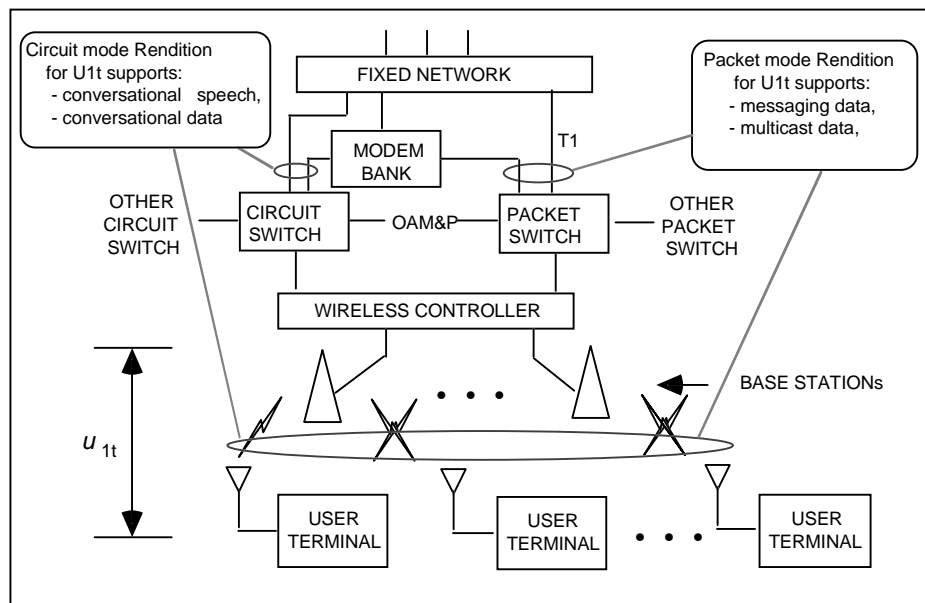


Figure C.1-3a Rendition 1 — u_{1t} , Two-Way Wide-Area Wireless Link

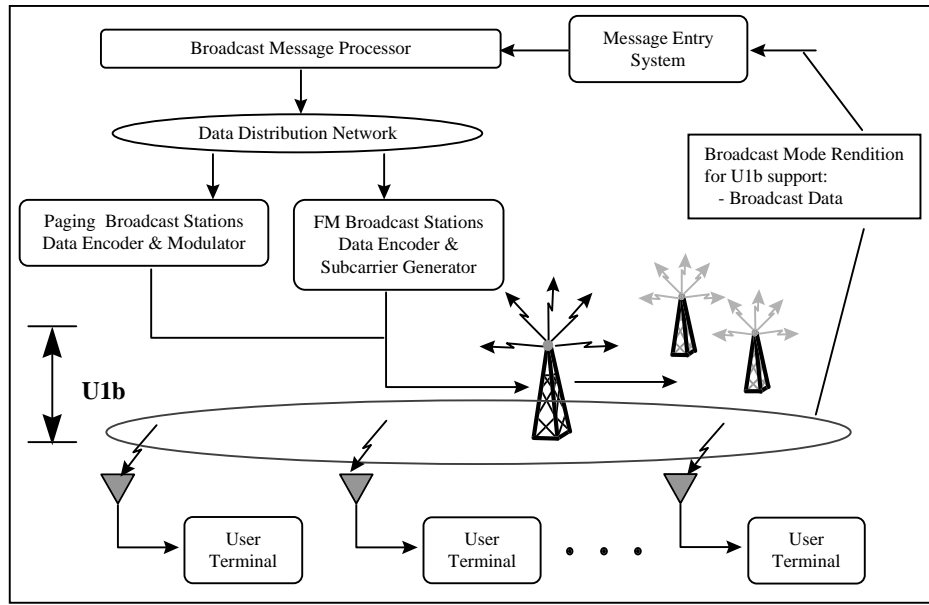


Figure C.1-3b Rendition 1 — u_{1b} , One-way Wide-Area Wireless Link

Table C.1-1a Wireless Wide Area Data Flows (u_{1t})

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
33	CVS	Commercial Vehicle Subsystem	driver and vehicle information	FMS	Fleet and Freight Management	U1t	messaging data, location data	bursty transactions
37	EM	Emergency Management	emergency dispatch requests	EVS	Emergency Vehicle Subsystem	U1t	Conversational speech, messaging data	Low delay bursty data or conversational speech
38	EM	Emergency Management	assigned route	EVS	Emergency Vehicle Subsystem	U1t	Conversational speech, messaging data	Low delay bursty data or conversational speech
39	EM	Emergency Management	Hazmat information	EVS	Emergency Vehicle Subsystem	U1t	Conversational speech, messaging data	Low delay bursty data or conversational speech
50	EM	Emergency Management	emergency acknowledge	VS	Vehicle	U1t	Conversational data conversational speech	Low delay bursty data
58	EVS	Emergency Vehicle Subsystem	emergency vehicle driver status update	EM	Emergency Management	U1t	messaging data	Low delay bursty data or live voice.
59	EVS	Emergency Vehicle Subsystem	emergency vehicle driver inputs	EM	Emergency Management	U1t	Conversational speech, messaging data	Bursty data or live voice. Minimum delay in data communication for forward and reverse link may be required
60	EVS	Emergency Vehicle Subsystem	emergency vehicle dispatch acknowledge	EM	Emergency Management	U1t	Conversational speech, messaging data	Bursty data or live voice. Minimum delay in data communication for forward and reverse link may be required
65	FMS	Fleet and Freight Management	fleet to driver update	CVS	Commercial Vehicle Subsystem	U1t	messaging data	Bursty data
91	ISP	Information Service Provider	trip plan	VS	Vehicle	U1t	Conversational data, Messaging data	Bursty data
92	ISP	Information Service Provider	traveler information	VS	Vehicle	U1t	messaging data, Broadcast data, Multicast	Bursty data
102	PIAS	Personal Information Access	emergency notification	EM	Emergency Management	U1t	Conversational data, messaging data, location data	Minimum delay in data communication for forward and reverse link maybe required. Location data for emergency response
107	PIAS	Personal Information Access	demand responsive transit request	TRMS	Transit Management	U1t	messaging data	Bursty messages
195	TRMS	Transit Management	emergency acknowledge	TRVS	Transit Vehicle Subsystem	U1t	Conversational data, messaging data	Minimum delay may be required
196	TRMS	Transit Management	driver instructions	TRVS	Transit Vehicle Subsystem	U1t	messaging data	
197	TRMS	Transit Management	bad tag list	TRVS	Transit Vehicle Subsystem	U1t	messaging data	Bursty data
199	TRMS	Transit Management	schedules, fare info request	TRVS	Transit Vehicle Subsystem	U1t	messaging data	Bursty data

Table C.1-1a Wireless Wide Area Data Flows (u_{1t})

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
200	TRMS	Transit Management	traveler information	TRVS	Transit Vehicle Subsystem	U1t	messaging data	Bursty data
210	TRVS	Transit Vehicle Subsystem	vehicle probe data	TRMS	Transit Management	U1t	Conversational data, messaging data, location data	Bursty data
211	TRVS	Transit Vehicle Subsystem	traveler information request	TRMS	Transit Management	U1t	Conversational data, messaging data	
212	TRVS	Transit Vehicle Subsystem	emergency notification	TRMS	Transit Management	U1t	messaging data	
217	VS	Vehicle	emergency notification	EM	Emergency Management	U1t	Conversational speech, messaging data, location data	Bursty data and live speech. Location data for emergency response
219	VS	Vehicle	traveler information request	ISP	Information Service Provider	U1t	Conversational data, messaging data	
220	VS	Vehicle	trip request	ISP	Information Service Provider	U1t	Conversational data, messaging data	Busrty data
221	VS	Vehicle	trip confirmation	ISP	Information Service Provider	U1t	Conversational data, messaging data	Busrty data
222	VS	Vehicle	vehicle probe data	ISP	Information Service Provider	U1t	messaging data, location data	Busrty data
223	VS	Vehicle	yellow pages request	ISP	Information Service Provider	U1t	Conversational data, messaging data	
230	VS	Vehicle	map update request	X23	Map Update Provider	U1t	messaging data	Busrty data
253	X23	Map Update Provider	map updates	VS	Vehicle	U1t	messaging data, Multicast data	Service on request or by subscription
34	CVS	Commercial Vehicle Subsystem	on board vehicle data	FMS	Fleet and Freight Management	U1t,U2	messaging data	Bursty transactions
198	TRMS	Transit Management	request for vehicle measures	TRVS	Transit Vehicle Subsystem	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
201	TRMS	Transit Management	route assignment	TRVS	Transit Vehicle Subsystem	U1t,U2	messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
209	TRVS	Transit Vehicle Subsystem	transit vehicle conditions	TRMS	Transit Management	U1t,U2	messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
213	TRVS	Transit Vehicle Subsystem	fare and payment status	TRMS	Transit Management	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing

Table C.1-1a Wireless Wide Area Data Flows (u_{1t})

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
								by specific locations at speeds up to 70 mph
214	TRVS	Transit Vehicle Subsystem	transit vehicle passenger and use data	TRMS	Transit Management	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph

Table C.1-1b Wireless Wide Area Data Flows (u_{1b})

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
73	ISP	Information Service Provider	broadcast information	PIAS	Personal Information Access	W,U1b	messaging data,Broadcast data, Multicast	Free services & services that require subscription
80	ISP	Information Service Provider	broadcast information	RTS	Remote Traveler Support	U1b	messaging data,Broadcast data, Multicast	Free services and services that require subscription
90	ISP	Information Service Provider	broadcast information	VS	Vehicle	U1b	messaging data,Broadcast data, Multicast	Free services and services that require subscription
92	ISP	Information Service Provider	traveler information	VS	Vehicle	U1t, U1b	messaging data,Broadcast data, Multicast	Bursty data

Rendition 2: (u_2)

The u_2 link is required to provide service between tetherless and close-proximity base stations, as occurs when a tetherless user communicates with a toll station for toll collection, a parking lot booth for fee collection, or the reception of information from roadside transmitters (roadside sign information). The primary use for this link is for rapid query-response interchanges and for local broadcast of information to nearby mobile users. The interchange must take place quickly as the vehicle will need the response for subsequent action, and the isolation of various users from jamming each other is based on range between user and base station, more than different frequencies. When the data flow is one directional, it is typically a broadcast function. As shown in Figure C.1-4, the u_2 link provides wireless communication between the mobile user and the stationary user, or in the reverse direction. Because this user is local to the site of the communication, the messages pass only from user to transmitter to receiver to user.

This rendition supports the data flows listed in Table C.1-2.

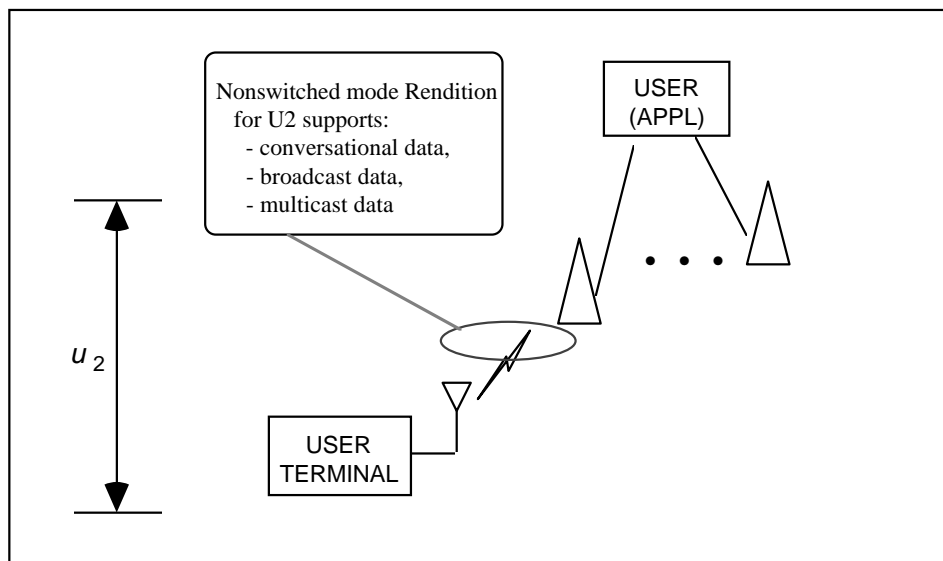


Figure C.1-4 Rendition 2 – u_2 Close Proximity Mobile to Stationary User Link

Table C.1-2 Short Range (Close-Proximity Mobile-Fixed) Wireless Data Flows (u_2)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
34	CVS	Commercial Vehicle Subsystem	on board vehicle data	FMS	Fleet and Freight Management	U1t,U2	messaging data	Bursty transactions
198	TRMS	Transit Management	request for vehicle measures	TRVS	Transit Vehicle Subsystem	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
201	TRMS	Transit Management	route assignment	TRVS	Transit Vehicle Subsystem	U1t,U2	messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
209	TRVS	Transit Vehicle Subsystem	transit vehicle conditions	TRMS	Transit Management	U1t,U2	messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
213	TRVS	Transit Vehicle Subsystem	fare and payment status	TRMS	Transit Management	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
214	TRVS	Transit Vehicle Subsystem	transit vehicle passenger and use data	TRMS	Transit Management	U1t,U2	Conversational data, messaging data	Bursty data using widearea wireless or short rang while passing by specific locations at speeds up to 70 mph
21	CVCS	Commercial Vehicle Check	clearance event record	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
22	CVCS	Commercial Vehicle Check	pass/pull-in	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
23	CVCS	Commercial Vehicle Check	safety inspection record	CVS	Commercial Vehicle Subsystem	U2	Conversational Data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
24	CVCS	Commercial Vehicle Check	screening request	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
25	CVCS	Commercial Vehicle	lock tag data request	CVS	Commercial Vehicle	U2	Conversational Data	

Table C.1-2 Short Range (Close-Proximity Mobile-Fixed) Wireless Data Flows (u_2)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
		Check			Subsystem			
26	CVCS	Commercial Vehicle Check	border clearance request	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
27	CVCS	Commercial Vehicle Check	on-board safety request	CVS	Commercial Vehicle Subsystem	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
28	CVCS	Commercial Vehicle Check	border clearance event record	CVS	Commercial Vehicle Subsystem	U2	Conversational Data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
29	CVS	Commercial Vehicle Subsystem	border clearance data	CVCS	Commercial Vehicle Check	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
30	CVS	Commercial Vehicle Subsystem	on board safety data	CVCS	Commercial Vehicle Check	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
31	CVS	Commercial Vehicle Subsystem	screening data	CVCS	Commercial Vehicle Check	U2	Conversational data	Short range communication, for moving vehicles when passing by specific locations at speeds up to 70 mph
32	CVS	Commercial Vehicle Subsystem	lock tag data	CVCS	Commercial Vehicle Check	U2	Conversational Data	
61	EVS	Emergency Vehicle Subsystem	emergency vehicle preemption request	RS	Roadway Subsystem	U2	Conversational data	Short range bursty data communication while in motion, when passing by specific locations at speeds up to 70 mph
115	PMS	Parking Management	request tag data	VS	Vehicle	U2	Conversational data	Data transfer while in motion, when passing the specific locations at speeds up to 70 mph
116	PMS	Parking Management	tag update	VS	Vehicle	U2	Conversational data	Data transfer while in motion, when passing the specific locations at speeds up to 70 mph
136	RS	Roadway Subsystem	AHS control data	VS	Vehicle	U2	messaging data	Data transfer while in motion, when passing the specific locations at

Table C.1-2 Short Range (Close-Proximity Mobile-Fixed) Wireless Data Flows (u_2)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
								speeds up to 70 mph
137	RS	Roadway Subsystem	vehicle signage data	VS	Vehicle	U2	messaging data	Data transfer while in motion, when passing the specific locations at speeds up to 70 mph
138	RS	Roadway Subsystem	intersection status	VS	Vehicle	U2	messaging data	Data transfer while in motion, when passing the specific locations at speeds up to 70 mph
139	RS	Roadway Subsystem	request tag data	VS	Vehicle	U2	Messaging data	
161	TCS	Toll Collection	tag update	VS	Vehicle	U2	Conversational Data	Data communication while passing by specific locations at speeds up to 70 mph
162	TCS	Toll Collection	request tag data	VS	Vehicle	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
208	TRVS	Transit Vehicle Subsystem	local signal priority request	RS	Roadway Subsystem	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
224	VS	Vehicle	tag data	PMS	Parking Management	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
225	VS	Vehicle	AHS vehicle data	RS	Roadway Subsystem	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
226	VS	Vehicle	vehicle probe data	RS	Roadway Subsystem	U2	Messaging Data	Data communication while passing by specific locations at speeds up to 70 mph
227	VS	Vehicle	tag data	TCS	Toll Collection	U2	Conversational data	Data communication while passing by specific locations at speeds up to 70 mph
236	X10	CVO Inspector	CVC override mode	CVCS	Commercial Vehicle Check	U2	Conversational data, messaging data	

Rendition 3: (u_3)

The u_3 link is required to provide communication between two (or more) tetherless users, as occurs in implementing the Automated Highway System (AHS). As shown in Figure C.1-5, the u_3 link provides time critical mostly line-of-sight data communication between tetherless users. This is still an area of research and standards for this link are in their infancy. The typical data flows include:

	Source	Architecture Flow	Destination	Communication Service
180	VS	veh to veh cord	X34	Conversational data
207	X34	Speed and Headway	VS	Conversational data
208	X34	veh to veh cord	VS	Conversational data

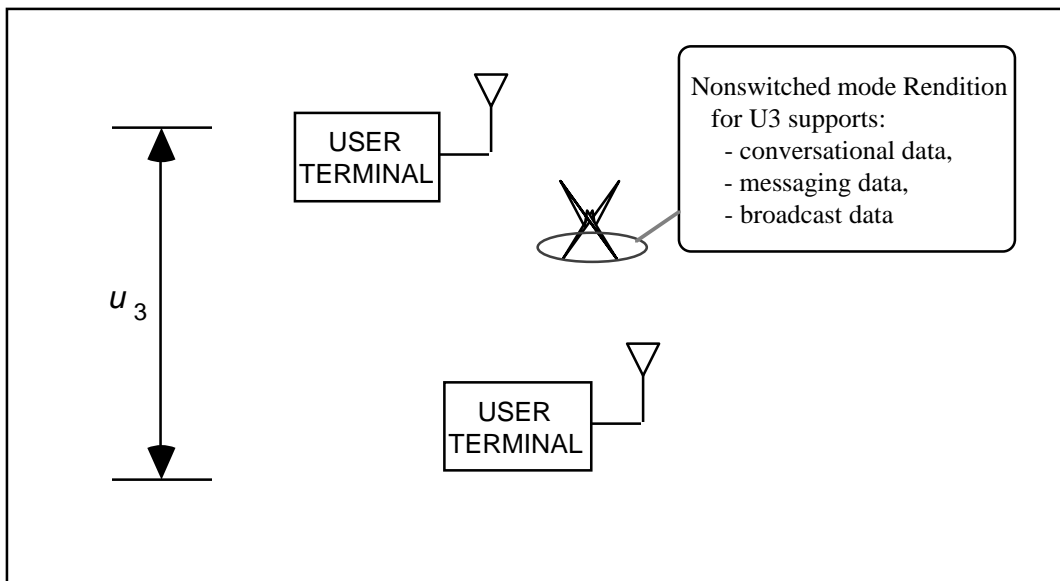


Figure C.1-5 Rendition 3 – u_3 , Close Proximity Vehicle-to-Vehicle Connection

Rendition 4: (w)

The w link mostly makes use of existing public telecommunications services to provide communication between fixed users. When the fixed users are not local and usage rates are low, the normal telco connection is used, whereas for heavily loaded communications, a dedicated link may be installed or leased from the telco. As shown in Figure C.1-6, the w link provides connection from the user, either through an on-site switch (PBX) or directly (the dotted box indicates the switch may not be used) to the public service provider (Internet, PDN or ISDN, etc.), as in the case where access to the Internet was through a cable television service and the entire capacity was used for the single user terminal. The dedicated connection would usually only apply to heavy usage links.

Note that in the figure for the wireline connection, Rendition 4, digital transmission can make use of the dedicated line, between single users when high loading is usual, or between switches to spread its capacity among many users.

This rendition supports the data flows listed in Table C.1-3.

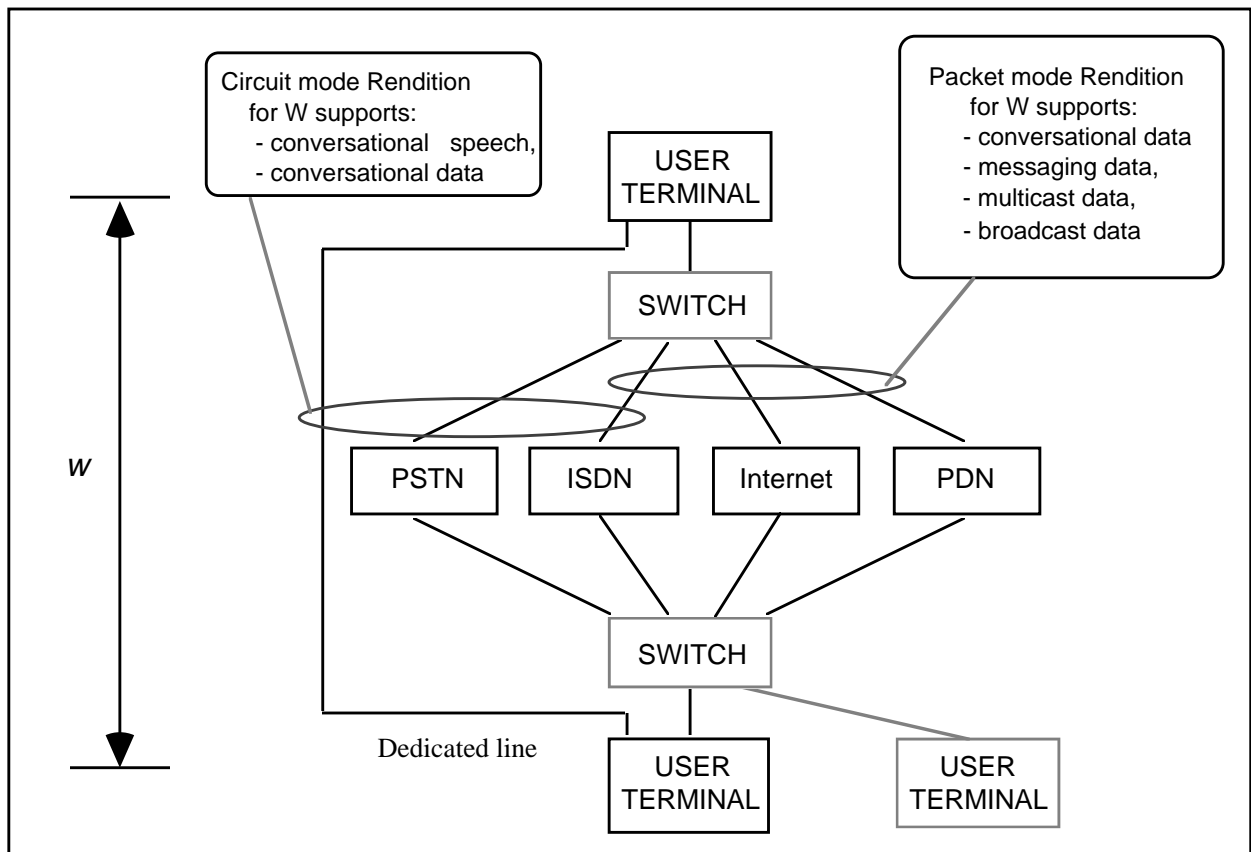


Figure C.1-6. Rendition 4 – w , The Wireline Connection

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
3	CVAS	Commercial Vehicle Administration	CVO database update	CVCS	Commercial Vehicle Check	W	Conversational data, messaging data	
4	CVAS	Commercial Vehicle Administration	international border crossing data	CVCS	Commercial Vehicle Check	W	messaging data	
6	CVAS	Commercial Vehicle Administration	compliance review report	FMS	Fleet and Freight Management	W	messaging data	
7	CVAS	Commercial Vehicle Administration	activity reports	FMS	Fleet and Freight Management	W	messaging data	
8	CVAS	Commercial Vehicle Administration	operational data	PS	Planning Subsystem	W	messaging data	
9	CVAS	Commercial Vehicle Administration	payment request	X21	Financial Institution	W	Conversational data, messaging data	
10	CVAS	Commercial Vehicle Administration	tax-credentials-fees request	X22	Government Administrators	W	messaging data	
11	CVAS	Commercial Vehicle Administration	credentials and safety information request	X59	Other CVAS	W	messaging data	
12	CVAS	Commercial Vehicle Administration	CVAS information exchange	X59	Other CVAS	W	messaging data	
13	CVAS	Commercial Vehicle Administration	violation notification	X62	Enforcement Agency	W	messaging data	
14	CVAS	Commercial Vehicle Administration	license request	X64	DMV	W	messaging data	
15	CVAS	Commercial Vehicle Administration	credentials and safety information response	X65	CVO Information Requestor	W	messaging data	
16	CVCS	Commercial Vehicle Check	credentials information request	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
17	CVCS	Commercial Vehicle Check	roadside log update	CVAS	Commercial Vehicle Administration	W	Messaging data	
18	CVCS	Commercial Vehicle Check	citation and accident data	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
19	CVCS	Commercial Vehicle Check	safety information request	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
20	CVCS	Commercial Vehicle Check	international border crossing data update	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
35	CVS	Commercial Vehicle Subsystem	processed cargo data	VS	Vehicle	W	messaging data	
36	CVS	Commercial Vehicle Subsystem	lock tag data request	X08	Commercial Vehicle	W	Conversational Data	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
40	EM	Emergency Management	Hazmat information request	FMS	Fleet and Freight Management	W	Conversational data, messaging data	
41	EM	Emergency Management	emergency vehicle route request	ISP	Information Service Provider	W	Conversational speech, messaging data	
42	EM	Emergency Management	incident information	ISP	Information Service Provider	W	Conversational speech, messaging data	
44	EM	Emergency Management	operational data	PS	Planning Subsystem	W	Conversational data, messaging data	
46	EM	Emergency Management	incident information	TMS	Traffic Management	W	Conversational data, messaging data	
47	EM	Emergency Management	emergency vehicle greenwave request	TMS	Traffic Management	W	Conversational data conversational speech	
48	EM	Emergency Management	incident response status	TMS	Traffic Management	W	Conversational data, messaging data	
49	EM	Emergency Management	transit emergency coordination data	TRMS	Transit Management	W	Conversational data, messaging data	
51	EM	Emergency Management	emergency status	X13	E911 or ETS	W	Conversational data conversational speech	
52	EM	Emergency Management	map update request	X23	Map Update Provider	W	messaging data	
53	EM	Emergency Management	emergency coordination	X30	Other EM	W	Conversational data, messaging data	
54	EMMS	Emissions Management	operational data	PS	Planning Subsystem	W	messaging data	
55	EMMS	Emissions Management	vehicle pollution criteria	RS	Roadway Subsystem	W	messaging data	
56	EMMS	Emissions Management	widearea statistical pollution information	TMS	Traffic Management	W	messaging data	
57	EMMS	Emissions Management	map update request	X23	Map Update Provider	W	messaging data	
62	FMS	Fleet and Freight Management	tax filing, audit data	CVAS	Commercial Vehicle Administration	w	messaging data	
63	FMS	Fleet and Freight Management	credential application	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
64	FMS	Fleet and Freight Management	information request	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
66	FMS	Fleet and Freight Management	Hazmat information	EM	Emergency Management	W	Conversational data, messaging data	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
67	FMS	Fleet and Freight Management	route request	ISP	Information Service Provider	W	Conversational data, messaging data	
68	FMS	Fleet and Freight Management	intermod CVO coord	X01	Intermodal Freight Shipper	W	messaging data	
69	FMS	Fleet and Freight Management	intermod CVO coord	X60	Intermodal Freight Depot	W	messaging data	
70	ISP	Information Service Provider	emergency vehicle route	EM	Emergency Management	W	Conversational speech, messaging data	
71	ISP	Information Service Provider	incident information request	EM	Emergency Management	W	Conversational speech, messaging data	
72	ISP	Information Service Provider	route plan	FMS	Fleet and Freight Management	W	messaging data	
76	ISP	Information Service Provider	parking lot data request	PMS	Parking Management	W	messaging data	
77	ISP	Information Service Provider	parking reservations request	PMS	Parking Management	W	messaging data	
78	ISP	Information Service Provider	road network use	PS	Planning Subsystem	W	messaging data	
79	ISP	Information Service Provider	traveler information	RTS	Remote Traveler Support	W	Broadcast data, Multicast data	
81	ISP	Information Service Provider	trip plan	RTS	Remote Traveler Support	W	Conversational Data	
82	ISP	Information Service Provider	request for toll schedules	TAS	Toll Administration	W	messaging data	
83	ISP	Information Service Provider	incident notification	TMS	Traffic Management	W	Conversational Data	
84	ISP	Information Service Provider	request for traffic information	TMS	Traffic Management	W	messaging data	
85	ISP	Information Service Provider	logged route plan	TMS	Traffic Management	W	Conversational data, Messaging data	
86	ISP	Information Service Provider	road network use	TMS	Traffic Management	W	messaging data	
87	ISP	Information Service Provider	transit information request	TRMS	Transit Management	W	messaging data	
88	ISP	Information Service Provider	selected routes	TRMS	Transit Management	W	Conversational data, Messaging data	
89	ISP	Information Service Provider	demand responsive transit request	TRMS	Transit Management	W	messaging data	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
93	ISP	Information Service Provider	intermodal information	X02	Intermodal Transportation Service Provider	W	messaging data	
94	ISP	Information Service Provider	payment request	X21	Financial Institution	W	Conversational data, messaging data	
95	ISP	Information Service Provider	map update request	X23	Map Update Provider	W	messaging data	
96	ISP	Information Service Provider	travel service reservation	X24	Yellow Pages Service Providers	W	messaging data	
97	ISP	Information Service Provider	traffic information	X27	Media	W	messaging data	
98	ISP	Information Service Provider	incident information	X27	Media	W	messaging data	
99	ISP	Information Service Provider	traffic information	X28	Media Operator	W	messaging data, Broadcast data, Multicast	
100	ISP	Information Service Provider	incident information	X28	Media Operator	W	messaging data	
101	ISP	Information Service Provider	ISP coord	X31	Other ISP	W	messaging data	
109	PMS	Parking Management	parking lot reservation confirmation	ISP	Information Service Provider	W	messaging data	
110	PMS	Parking Management	parking availability	ISP	Information Service Provider	W	messaging data	
111	PMS	Parking Management	operational data	PS	Planning Subsystem	W	messaging data	
112	PMS	Parking Management	demand management price change response	TMS	Traffic Management	W	messaging data	
113	PMS	Parking Management	parking availability	TMS	Traffic Management	W	messaging data	
114	PMS	Parking Management	transit parking coordination	TRMS	Transit Management	W	Messaging data	
117	PMS	Parking Management	payment request	X21	Financial Institution	W	Conversational data, messaging data	
118	PMS	Parking Management	parking status	X36	Parking Operator	W	messaging data	
119	PMS	Parking Management	parking availability	X37	Parking Service Provider	W	messaging data	
120	PMS	Parking Management	violation notification	X62	Enforcement Agency	W	messaging data	
121	PMS	Parking Management	license request	X64	DMV	W	Messaging data	
122	PS	Planning Subsystem	planning data	TMS	Traffic Management	W	messaging data	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
123	PS	Planning Subsystem	map update request	X23	Map Update Provider	W	Messaging data	
124	PS	Planning Subsystem	planning data	X25	Transportation Planners	W	messaging data	
125	RS	Roadway Subsystem	pollution data	EMMS	Emissions Management	W	messaging data	
126	RS	Roadway Subsystem	fault reports	TMS	Traffic Management	W	Conversational data, messaging data	
127	RS	Roadway Subsystem	request for right of way	TMS	Traffic Management	W	Conversational Data	
128	RS	Roadway Subsystem	vehicle probe data	TMS	Traffic Management	W	messaging data	
129	RS	Roadway Subsystem	AHS status	TMS	Traffic Management	W	messaging data	
130	RS	Roadway Subsystem	incident data	TMS	Traffic Management	W	messaging data	
131	RS	Roadway Subsystem	freeway control status	TMS	Traffic Management	w	messaging data	
132	RS	Roadway Subsystem	signal control status	TMS	Traffic Management	W	messaging data	
133	RS	Roadway Subsystem	HOV data	TMS	Traffic Management	W	Messaging data	
134	RS	Roadway Subsystem	signal priority request	TMS	Traffic Management	W	messaging data	
135	RS	Roadway Subsystem	local traffic flow	TMS	Traffic Management	W	messaging data	
140	RS	Roadway Subsystem	grant right of way and/or stop traffic	X29	Multimodal Crossings	W	Conversational data, messaging data	
142	RTS	Remote Traveler Support	yellow pages request	ISP	Information Service Provider	W	Conversational data, Messaging Data	
143	RTS	Remote Traveler Support	trip request	ISP	Information Service Provider	W	Conversational Data	
144	RTS	Remote Traveler Support	traveler information request	ISP	Information Service Provider	W	messaging data	
145	RTS	Remote Traveler Support	demand responsive transit request	ISP	Information Service Provider	W	messaging data	
146	RTS	Remote Traveler Support	emergency notification	TRMS	Transit Management	W	Conversational data, Messaging Data	
147	RTS	Remote Traveler Support	transit request	TRMS	Transit Management	W	messaging data	
148	RTS	Remote Traveler Support	traveler information request	TRMS	Transit Management	W	messaging data	
149	RTS	Remote Traveler Support	map update request	X23	Map Update Provider	W	messaging data	
150	TAS	Toll Administration	toll schedules	ISP	Information Service Provider	W	messaging data	
151	TAS	Toll Administration	operational data	PS	Planning Subsystem	W	messaging data	
152	TAS	Toll Administration	toll instructions	TCS	Toll Collection	W	messaging data	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
153	TAS	Toll Administration	demand management price change response	TMS	Traffic Management	W	messaging data	
154	TAS	Toll Administration	probe data	TMS	Traffic Management	W	messaging data	
156	TAS	Toll Administration	payment request	X21	Financial Institution	W	messaging data	
157	TAS	Toll Administration	toll revenues and summary reports	X44	Toll Service Provider	W	messaging data	
158	TAS	Toll Administration	violation notification	X62	Enforcement Agency	W	messaging data	
159	TAS	Toll Administration	license request	X64	DMV	W	messaging data	
160	TCS	Toll Collection	toll transactions	TAS	Toll Administration	W	messaging data	
163	TMS	Traffic Management	incident information request	EM	Emergency Management	W	Messaging data	
164	TMS	Traffic Management	incident notification	EM	Emergency Management	W	Messaging data	
165	TMS	Traffic Management	pollution state data request	EMMS	Emissions Management	W	messaging data	
166	TMS	Traffic Management	traffic information	ISP	Information Service Provider	W	messaging data	
167	TMS	Traffic Management	parking instructions	PMS	Parking Management	W	messaging data	
168	TMS	Traffic Management	demand management price change request	PMS	Parking Management	W	messaging data	
169	TMS	Traffic Management	operational data	PS	Planning Subsystem	W	messaging data	
170	TMS	Traffic Management	freeway control data	RS	Roadway Subsystem	W	messaging data	
171	TMS	Traffic Management	signal control data	RS	Roadway Subsystem	W	messaging data	
172	TMS	Traffic Management	AHS control information	RS	Roadway Subsystem	W	messaging data	
173	TMS	Traffic Management	signage data	RS	Roadway Subsystem	W	messaging data	
174	TMS	Traffic Management	demand management price change request	TAS	Toll Administration	W	messaging data	
175	TMS	Traffic Management	traffic information	TRMS	Transit Management	W	messaging data	
176	TMS	Traffic Management	demand management price change request	TRMS	Transit Management	W	messaging data	
177	TMS	Traffic Management	signal priority status	TRMS	Transit Management	W	Conversational data, messaging data	
178	TMS	Traffic Management	event confirmation	X19	Event Promoters	W	messaging data	
179	TMS	Traffic Management	map update request	X23	Map Update Provider	W	messaging data	
180	TMS	Traffic Management	TMC coord.	X35	Other TM	W	messaging data	
181	TMS	Traffic Management	violation notification	X62	Enforcement Agency	W	messaging data	
182	TMS	Traffic Management	license request	X64	DMV	W	messaging data	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
183	TRMS	Transit Management	security alarms	EM	Emergency Management	W	Conversational data, messaging data, location data	Location data for emergency response
184	TRMS	Transit Management	demand responsive transit plan	ISP	Information Service Provider	W	Conversational data, messaging data	
185	TRMS	Transit Management	transit and fare schedules	ISP	Information Service Provider	W	messaging data	
186	TRMS	Transit Management	transit request confirmation	ISP	Information Service Provider	W	messaging data	
188	TRMS	Transit Management	parking lot transit response	PMS	Parking Management	W	messaging data, Broadcast data, Multicast	
189	TRMS	Transit Management	operational data	PS	Planning Subsystem	W	messaging data	
190	TRMS	Transit Management	traveler information	RTS	Remote Traveler Support	W	messaging data, Multicast data	
191	TRMS	Transit Management	transit and fare schedules	RTS	Remote Traveler Support	W	messaging data, Multicast data	
192	TRMS	Transit Management	emergency acknowledge	RTS	Remote Traveler Support	W	Conversational data, messaging data	
193	TRMS	Transit Management	request for transit signal priority	TMS	Traffic Management	W	messaging data	
194	TRMS	Transit Management	demand management price change response	TMS	Traffic Management	W	messaging data	
202	TRMS	Transit Management	intermodal information	X02	Intermodal Transportation Service Provider	W	messaging data	
203	TRMS	Transit Management	payment request	X21	Financial Institution	W	Conversational data, messaging data	
204	TRMS	Transit Management	map update request	X23	Map Update Provider	W	messaging data	
205	TRMS	Transit Management	TRMS coord	X33	Other TRM	W	messaging data	
206	TRMS	Transit Management	camera control	X42	Secure Area Environment	W	Conversational data, messaging data	
207	TRMS	Transit Management	violation notification	X62	Enforcement Agency	W	messaging data	
215	TRVS	Transit Vehicle Subsystem	traveler advisory request	VS	Vehicle	W	Messaging data	
216	VS	Vehicle	cargo data request	CVS	Commercial Vehicle Subsystem	W	Messaging data	
218	VS	Vehicle	vehicle location	EVS	Emergency Vehicle	W	Broadcast data	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
					Subsystem			
228	VS	Vehicle	vehicle location	TRVS	Transit Vehicle Subsystem	W	Broadcast data	
229	VS	Vehicle	vehicle control	X03	Basic Vehicle	W	Conversational Data	
231	X01	Intermodal Freight Shipper	intermod CVO coord	FMS	Fleet and Freight Management	W	messaging data	
232	X02	Intermodal Transportation Service Provider	intermodal information	ISP	Information Service Provider	W	messaging data	
233	X02	Intermodal Transportation Service Provider	intermodal information	TRMS	Transit Management	W	messaging data	
234	X03	Basic Vehicle	vehicle measures	VS	Vehicle	W	Broadcast data	
235	X08	Commercial Vehicle	vehicle measures	CVS	Commercial Vehicle Subsystem	W	Broadcast data	
237	X13	E911 or ETS	incident information	EM	Emergency Management	W	Conversational data conversational spec, location data	Location data for emergency response
238	X19	Event Promoters	event plans	TMS	Traffic Management	W	messaging data, Multicast data	
239	X21	Financial Institution	transaction status	CVAS	Commercial Vehicle Administration	W	Conversational data, messaging data	
240	X21	Financial Institution	transaction status	ISP	Information Service Provider	W	Conversational data, messaging data	
241	X21	Financial Institution	transaction status	PMS	Parking Management	W	Conversational data, messaging data	
242	X21	Financial Institution	transaction status	TAS	Toll Administration	W	Conversational data, messaging data	
243	X21	Financial Institution	transaction status	TRMS	Transit Management	W	Conversational data, messaging data	
244	X22	Government Administrators	regulations	CVAS	Commercial Vehicle Administration	W	messaging data, Multicast data	
245	X23	Map Update Provider	map updates	EM	Emergency Management	W	messaging data, Multicast data	
246	X23	Map Update Provider	map updates	EMMS	Emissions Management	W	messaging data	
247	X23	Map Update Provider	map updates	ISP	Information Service Provider	W	messaging data, Multicast data	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
249	X23	Map Update Provider	map updates	PS	Planning Subsystem	W	messaging data, Broadcast data, Multicast	
250	X23	Map Update Provider	map updates	RTS	Remote Traveler Support	W	messaging data	
251	X23	Map Update Provider	map updates	TMS	Traffic Management	W	messaging data, Multicast data	
252	X23	Map Update Provider	map updates	TRMS	Transit Management	W	messaging data, Multicast data	
254	X24	Yellow Pages Service Providers	travel service info	ISP	Information Service Provider	W	messaging data	
255	X25	Transportation Planners	planning data	PS	Planning Subsystem	W	messaging data	
256	X27	Media	external reports	ISP	Information Service Provider	W	messaging data, Multicast data	
257	X28	Media Operator	incident notification	ISP	Information Service Provider	W	messaging data, Broadcast data, Multicast	
258	X29	Multimodal Crossings	right of way preemption request	RS	Roadway Subsystem	W	Conversational data, messaging data	
259	X29	Multimodal Crossings	request for right of way	RS	Roadway Subsystem	W	Conversational data, messaging data	
260	X30	Other EM	emergency coordination	EM	Emergency Management	W	Conversational data, messaging data	
261	X31	Other ISP	ISP coord	ISP	Information Service Provider	W	messaging data	
262	X33	Other TRM	TRMS coord	TRMS	Transit Management	W	messaging data	
263	X35	Other TM	TMC coord.	TMS	Traffic Management	W	messaging data	
264	X37	Parking Service Provider	request for performance data	PMS	Parking Management	W	messaging data	
265	X51	Transit Vehicle	vehicle measures	TRVS	Transit Vehicle Subsystem	W	Broadcast data	
266	X58	Weather Service	weather information	ISP	Information Service Provider	W	messaging data, Broadcast data, Multicast	
267	X58	Weather Service	weather information	TMS	Traffic Management	W	messaging data, Broadcast data, Multicast	

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
268	X59	Other CVAS	CVAS information exchange	CVAS	Commercial Vehicle Administration	W	messaging data	
269	X59	Other CVAS	credentials and safety information response	CVAS	Commercial Vehicle Administration	W	messaging data	
270	X60	Intermodal Freight Depot	intermod CVO coord	FMS	Fleet and Freight Management	W	messaging data	
271	X64	DMV	registration	CVAS	Commercial Vehicle Administration	W	messaging data	
272	X64	DMV	vehicle characteristics	PMS	Parking Management	W	Messaging data	
273	X64	DMV	registration	TAS	Toll Administration	W	messaging data	
274	X64	DMV	registration	TMS	Traffic Management	W	messaging data	
275	X65	CVO Information Requestor	credentials and safety information request	CVAS	Commercial Vehicle Administration	W	messaging data	
73	ISP	Information Service Provider	broadcast information	PIAS	Personal Information Access	W,U1b	messaging data,Broadcast data, Multicast	Free services & services that require subscription
1	CVAS	Commercial Vehicle Administration	credentials information	CVCS	Commercial Vehicle Check	W,U1t	Conversational data, messaging data	The CVAS could be a transportable entity. Some tranactions may need real time support
2	CVAS	Commercial Vehicle Administration	safety information	CVCS	Commercial Vehicle Check	W,U1t	Conversational data, messaging data	
5	CVAS	Commercial Vehicle Administration	electronic credentials	FMS	Fleet and Freight Management	W,U1t	messaging data	The CVAS could be a transportable entity.
43	EM	Emergency Management	emergency acknowledge	PIAS	Personal Information Access	W,U1t	Conversational data, messaging data	Wide area communication to PDA
45	EM	Emergency Management	emergency acknowledge	RTS	Remote Traveler Support	W,U1t	Conversational speech, messaging data	Wide area wireless communication to transportable units
74	ISP	Information Service Provider	trip plan	PIAS	Personal Information Access	W,U1t	Conversational data, Messaging data	Bursty data
75	ISP	Information Service Provider	traveler information	PIAS	Personal Information Access	W,U1t	Broadcast data,Multicast data	Bursty data upon request. Bursty or continuous transmission for one-way systems. Free services and services that require subscription.
103	PIAS	Personal Information	traveler information	ISP	Information Service	W,U1t	messaging data	Bursty messages, Wireless

Table C.1-3 Wireline Connection Data Flows (w)

Flow #	Source	Source Name	Architecture Flow	Destination	Destination Name	Interconnects	Communication Service	Rationale
		Access	request		Provider			to PDA. Location data for value added services.
104	PIAS	Personal Information Access	trip request	ISP	Information Service Provider	W,U1t	Conversational Data, Messaging data	Bursty messages, Wireless to PDA
105	PIAS	Personal Information Access	trip confirmation	ISP	Information Service Provider	W,U1t	Conversational Data, Messaging data	Bursty messages. Wireless to PDA
106	PIAS	Personal Information Access	yellow pages request	ISP	Information Service Provider	W,U1t	Conversational Data, Messaging data	Bursty messages, Wireless to PDA
108	PIAS	Personal Information Access	map update request	X23	Map Update Provider	W,U1t	messaging data	Service on request or services by subscription
141	RTS	Remote Traveler Support	emergency notification	EM	Emergency Management	W,U1t	Conversational speech, messaging data, location data	RTS can be a transportable unit. Location data emergency response.
187	TRMS	Transit Management	demand responsive transit route	PIAS	Personal Information Access	W,U1t	messaging data	Bursty data
248	X23	Map Update Provider	map updates	PIAS	Personal Information Access	W,U1t	messaging data, Multicast data	Service on request or by subscription

The task here is to identify applicable technologies which will support the Level 0 Rendition. This requires assessing the technologies presented in Appendix D, and then mapping them onto the Rendition Level 0 diagram as shown in Figure C.2-1. Evaluation of these technologies yields the Architecture Interconnect Specifications. A host of existing and emerging technologies applicable to ITS are identified in Appendix D. This assessment covers the candidate communication technologies depicted in Figure C.2-1.

As an illustrative example, a set of communication technologies that are applicable to provide some or all of the services identified in the AIDs for the u_{it} link are listed in the highlighted box in Figure C.2-2. This figure shows the list of technologies superimposed on the u_{it} Level 1 rendition.



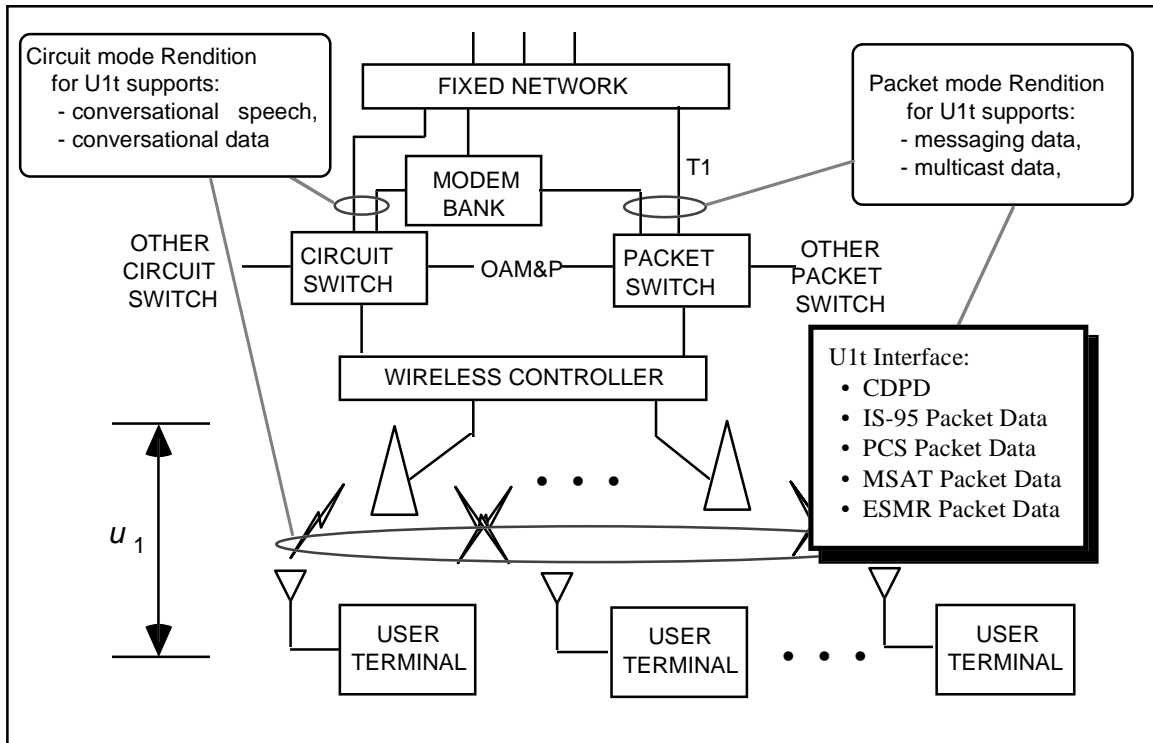


Figure C.2-2 Candidate Technologies for Rendition Level 1 – Two-Way Wide Area Wireless Link